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BIOLOGIA

Vol. 5 JUNE 1959 No. 1

Ueber einige neue oder bemerkenswerte Ascomyceten aus Pakistan IV.

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23. Didymosphaeria culmicola nov. spec.

Perithecia globosa, substrato immersa, late dispersa, 150-200 μ diam., fusca, apice ostiolo conico erumpentia. Paries apice 20 μ, base 10 μ crassitudine, cellulis rotundatis, 4-6 μ diam. compositus. Asci ellipsoidei vel clavati, bitunicati, 60-65 x 12-15 μ, 8-spori, paraphysoidis numerosis, fibrosis circumdati. Sporae fusoideae, media septatae et constrictae, 22-26 x 5-6 μ, fuscae, glabrae.

Hab. in caulibus emortuis *Panici antidotali* Rezt. —Pakistan: Lahore, Changa Manga, 19.10.1958, leg. S. Ahmad (sub. Nr. 14279).

Die einzeln dem Substrat eingesenkten und nur mit der kegelförmigen Mündung etwas hervorbrechenden, kugeligen, 150-200 μ grossen, braunen Fruchtkörper sind makroskopisch nur als kleine, dunkle Punkte erkennbar. Die Mündung ist ca. 30 μ hoch, anfangs von einem kleinzelligen, hyalinen Gewebe verschlossen und sich erst spät durch einen unregelmässig rundlichen Kanal öffnend. Die Fruchtkörperwand ist am Scheitel bis 20 μ, an der Basis noch bis 10 μ dick und besteht aus rundlichen, 4-6 μ grossen, nicht sehr derbwandigen, braunen Zellen. Die nicht sehr zahlreichen Asci sind ellipsoidisch oder etwas keulig, derb- und doppelwandig, 60-65 x 12-15 μ gross, achtsporig und von zahlreichen, fädigen Paraphysoiden umgeben. Die schräg einreihig im Ascus liegenden Ascosporen sind spindelförmig, in der Mitte septiert und deutlich eingeschnürt, 22-26 x 5-6 μ gross, braun und glattwandig.

Die vorliegende Art wurde isoliert und in Reinkultur beobachtet. Auf Malzagar wächst der Pilz langsam und bildet polsterförmige,

grau-braune, ziemlich dunkle Kissen als Luftmyzel und blaugraue Substratmyzelien. Diese Myzelien bestehen aus sehr dicht ineinander verwobenen, braunen, 1.5-2.5 μ dicken, relativ kurzgliederigen Hyphen. Soweit wir die Kultur verfolgen konnten wurde keine Konidienform gebildet.

Scheinpflug (1958) hat sich kürzlich in einer ausführlichen Arbeit mit der Gattung *Didymosphaeria* Fuck. auseinandergesetzt und auch ihre Variationsbreite an Hand einer grössern Zahl als Beispiele herausgegriffener Arten abzuklären versucht. Die oben beschriebene Art — wie

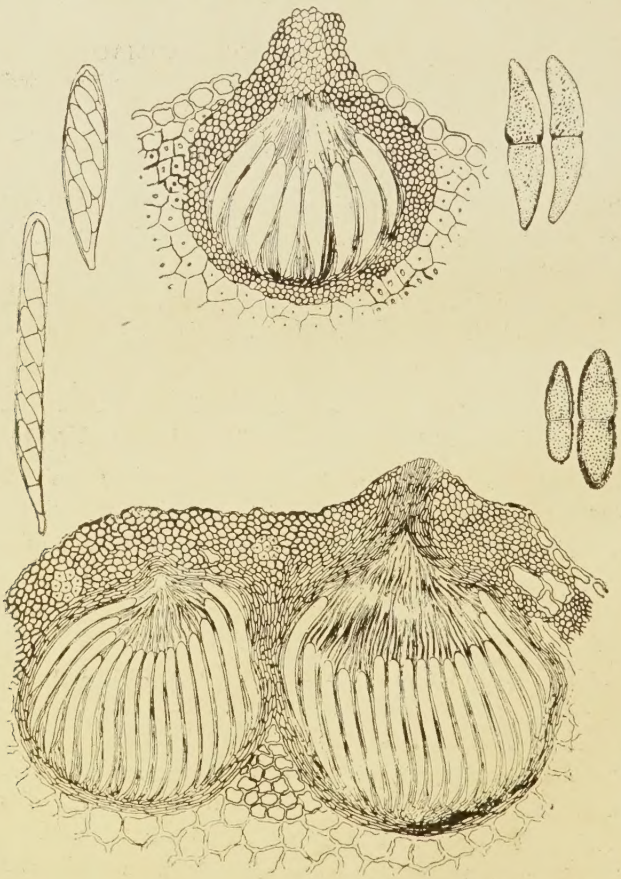

Abbildung 1. oben : Schnitt durch einen Fruchtkörper von *Didymosphaeria culmicola* Vergr. 250 X; links : Ascus, Vergr. 500 X; rechts : Ascosporen, Vergr. 1000 X. unten : *Didymosphaeria spinosa*, Mitte : Schnitt durch zwei Fruchtkörper Vergr. 250 X; links : Ascus Vergr. 500 X ; rechts: Ascosporen, Vergr. 1000 X.

auch die nächste — stimmt mit keiner der von ihm erwähnten Formen überein, dürfte aber der von ihm als ursprünglicher angesehenen Gruppe (z. B. mit *Didymosphaeria astragalina* Petr.) nahe stehen. Auch diese Art bildet in Reinkultur keine Konidienform aus, vermag aber verhältnismässig leicht unter den gebotenen Bedingungen ihre Hauptfruchtform zur Entwicklung zu bringen.

24. Didymosphaeria spinosa nov. spec.

Status ascophorus : Perithecia solitaria vel aggregata, globosa vel irregulariter tuberosa, substrato immersa, 180-220 μ diam., clypeo fusco tecta, ostiolo conico erumpentia. Paries 10-15 μ crassitudine, cellulis applanatis compositus. Asci numerosi, cylindracei, bitunicati, 90-100 x 8-9 μ, 8-spori. Sporae fusoideae, media vel sub media septatae et leniter constrictae, 14-20 x 4-5 μ, fuscae, numerosis spinulis hyalinis, ca. 3-4 μ longis ornatae.

Status conidiophorus : Pvcnidia solitaria, globosa, 70-120 μ diam. substrato immersa, apice ostiolata. Paries exteriore fuscus, interiore subhvalinus, cellulis rotundatis, tenuiter tunicatis, ca. 4 μ diam. compositus. Conidiophori cylindracei, 2-3 x 1.5-2 μ, hyalini. Conidiosporae solitariae, unicellulatae, subfuscae, cylindraceae, 6-8 x 2-3 μ leniter et irregulariter verrucosae.

Hab. in caulibus emortuis *Panici antidotali* Retz. - Pakistan : Lahore, Changa Manga, 19-10-1958, leg. S. Ahmad (sub. Nr. 14279).

Hauptfruchtform : Die 180-220 μ grossen, kugeligen oder durch gegenseitige Beeinflussung unregelmässigen Fruchtkörper sind dem Substrat eingesenkt; sie wachsen einzeln, meist aber zu wenigen in kleine Gruppen vereinigt und oft mehr oder weniger deutlich stromatisch verbunden. Ueber ihnen wächst—teilweise mit enizelnen Substratresten durchsetzt—ein dunkler, 30-40 μ dicker Klypeus aus derb wandigen, dunkelbraunen Zellen. Makroskopisch lassen sich die Fruchtkörper deswegen als schwach vorstehende, dunkle Knollen erkennen. Die Fruchtkörper selber sind dagegen relativ dünnwandig und aus deutlich abgeplatteten, bis 10 μ langen, ziemlich zartwandigen, bräunlichen Zellen aufgebaut, welche zuweilen dunkel inkrustiert sind. Der Klypeus wird von einer Mündung durchbrochen, welche ihn etwas emporwölbt und innen von einem schmalen Mündungskanal durchbohrt ist. Dieser Mündungskanal ist innen mit hyphenartigen, zuweilen

sehr dicht ineinander verwobenen Zellen ausgekleidet, die aus den Zellreihen der wand herauslaufen. Die Asci sind zylinderisch, von zahlreichen, fädigen Paraphysoiden umgeben, derb—und doppelwandig, 90-100 x 8-9 μ gross und achtsporig. Die Ascosporen liegen schräg einreihig; sie sind spindelförmig, in der Mitte oder oft auch wenig unterhalb septiert und schwach eingeschnürt, 14-20 x 4-5 μ gross, goldbraun und aussen deutlich mit dicht beieinander stehenden, ca. 3/4 μ hohen, hyalinen Stacheln besetzt.

Nebenfruchtform: Die kugeligen, 70-120 μ grossen Gehäuse sind dem Substrat vollständig eingesenkt. Am Scheitel besitzen sie eine atypische, sich erst recht spät unregelmässig öffnende Mündung; die Fruchtkörperwand setzt sich zusammen aus rundlichen, zu äusserst braunen und deutlich derbwandigen, innen hyalinen und zartwandigen, bis 4 μ grossen Zellen. Zu innerst entspringen der ganzen Wand entlang dornige oder fast regelmässig zylinderische, hyalin, bis 3 μ hohe und 1.5-2 μ dicke Konidienträger, an denen einzeln die mehr oder weniger zylinderischen, hellbraunen, 6-8 x 2-3 μ grossen, einzelligen, schwach und unregelmässig mit rundlichen Höckern skulptierten Konidien abgeschnürt werden.

Didymosphaeria spinosa (wegen der mit feinen Stacheln bewehrten Ascosporen) ist von der auf demselben Substrat vorkommenden *Didymosphaeria culmicola* deutlich verschieden. Die Gehäuse sind nach der von Scheinpflug (1958) vorgenommenen Einteilung der Gattung *Didymosphaeria* Fuck. am ehesten mit der *Didymosphaeria futilis* (Berk. et Br.) Rehm—Gruppe zu vergleichen, doch sind in Bezug auf die Sporen auch nähere Beziehungen mit der ebenfalls auf Gräsern vorkommenden *Didymosphaeria festucae* Wegelin unverkennbar. Auch diese Art besitzt spindelförmige Ascosporen, welche aber beudetend grösser sind und keinerlei Skulptierung aufweisen.

Da an Hand der Literatur bei der von Marchal und Steyaert (1929) beschriebenen *Didymosphaeria panici* sowohl bei den Fruchtkörpern wie auch vor allem bei den Sporen eine grosse Aehnlichkeit mit der vorliegenden Art angenommen werden musste, haben wir diese in unsere Untersuchung einbezogen. Dank der Vermittlung von Dr. R. L. Steyaert und dem Entgegenkommen der Direktion des Botanischen Gartens in Brüssel konnten wir das betreffende Originalmaterial untersuchen. Darnach handelt es sich dabei um eine *Didymosphaeria*, welche in den Stromata einer *Phyllachora*-art, wahrscheinlich *Phyllachora*

congruens Rehm, parasitiert und sich durch helle Gehäuse und spindelförmige, 11-16 x 3.5-5 μ grosse, braune und glattwandige Sporen auszeichnet. Dieser Pilz ist schon mehrmals, als *Phaeodothis tricuspidis* Syd. sogar als Typus einer eigenen Gattung, beschrieben worden (Sydow, 1904, 1939), später allerdings als in *Phyllachora*-stromata parasitierende *Didymosphaeria* Fuck. [meist als *Cryptodidymosphaeria* (Rehm) v. Höhn. aufgefasst] erkannt worden. Scheinpflug (1958) hat nun neuerdings die Identität mit *Didymosphaeria Winteri* Niessl nachgewiesen. Demnach ist die *Didymosphaeria spinosa* Form sicher von dem als *Didymosphaeria panici* beschriebenen Pilz verschieden.

Wie *Didymosphaeria culmicola* wurde auch *Didymosphaeria spinosa* isoliert und in Reinkultur beobachtet. Sie wächst durchschnittlich etwas rascher als *Didymosphaeria culmicola* und bildet auf Malzagar ein flacheres, ausgebreiteteres, wolliges Luftmyzel, das etwas heller ist und einen bräunlicheren Farbton aufweist. Die Hyphen sind zunächst hyalin, später färben sie sich graubraun an und werden auch deutlich dickwandig; dabei sind sie mit deutlichen, halbkugeligen Höckern skulptiert.

Es zeigt sich demnach im Myzel ein Merkmal, das schon bei den Ascosporen sehr auffällig war: die Skulptierung der Oberfläche. Da die Sporenskulptierung innerhalb der Gattung *Didymosphaeria* Fuck. schon mehrmals nachgewiesen worden ist (z. B. bei Scheinpflug, 1958) sind wir bei den uns zur Verfügung stehenden Reinkulturen von *Didymosphaeria oblitescens* (Berk. et Br.) Fuck., *Didymosphaeria rubicola* Berl. und *Didymosphaeria spartii* (Cast.) Fabre, den Myzelien nachgegangen. Keine dieser Arten liess aber irgend welche Skulptierung der Myzelien erkennen.

In Reinkulturen bildete der Pilz nach ungefähr einem Monat auch die Pyknidien einer Nebenfruchtform aus, die wir nachträglich auch auf dem natürlichen Substrat feststellen konnten. Sie gehört zweifellos in die Verwandtschaft von *Coniothyrium* Cda. Die Pyknidien besitzen aber deutliche Konidienträger, was nach Petrak und Sydow (1927) allerdings nicht ganz mit der Grundkonzeption der Gattung *Coniothyrium* übereinstimmt. Sie haben deshalb für derartige Formen die Gattung *Lichenoconium* aufgestellt, in diese Formgattung aber nicht nur Flechtenparasiten sondern auch auf Holz wachsende Formen eingereiht. Für diese Formen geben sie als mögliche Hauptfruchtformen

Pleosporaceen an; ob *Lichenoconium* tatsächlich eine gut abtrennbare Formgattung der Fungi imperfecti ist, erscheint fraglich.

Von einigen *Coniothyrium*-arten ist die Zugehörigkeit zu Pleosporaceen auch durch Kulturversuche nachgewiesen: *Leptosphaeria Michotii* (West.) Sacc. (Webster, 1955), *Leptosphaeria rusci* (Wall). Sacc. (Müller und Tomasevic, 1957), *Pleospora sparti-juncei* E. Müller (Müller, 1957).

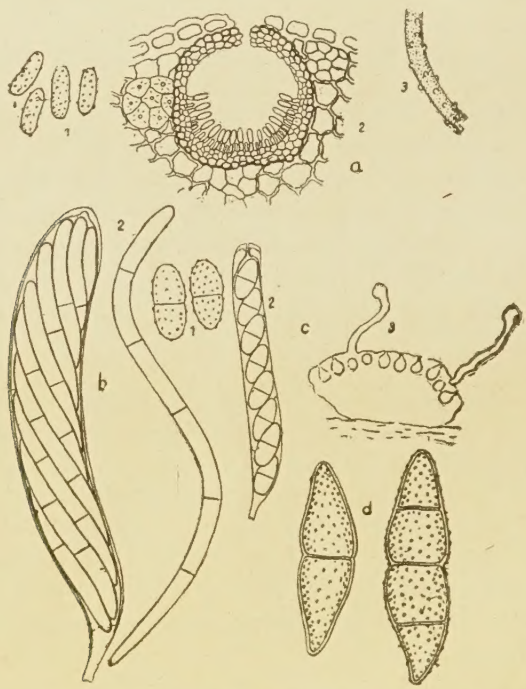

Abbildung 2. a) *Didymosphaeria spinosa*. 1) Konidien, Vergr. 1000 X. 2) Pyknidium im Schnitt; Vergr. 250 X. 3) Myzelhyphe, Vergr. 1000 X. b) *Cochliobolus sporoboli* 1) Ascus nit Sporen, 2) Ascospore, beide Vergr. 500 X. c) *Stilbocrea macrostoma* 1) Ascosporen, Vergr. 1000 X. 2) Ascus, Vergr. 500 X, 3) Schnitt durch ein Stroma, schematisch, 25 X. d) Ascosporen von *Trematosphaeria verrucosa*, Vergr. 1000 X.

25. **Tichothecium pygmaeum** Koerb.

Tichothecium pygmaeum Koerb. ist ein Flechtenparasit, der noch nie ausserhalb Flechtenthalli gefunden worden ist. Die Stellung der Gattung *Tichothecium* Koerb. ist noch unklar; sehr wahrscheinlich gehört sie—trotz der sehr dickwandigen Asci—zu den Sphaeriales und wäre dort in die Nähe von *Verrucaria* Th. Fr. zu stellen.

Auf Rindenstücken von *Salvadora oleoides* Dcne. die mit einer sterilen Krustenflechte überzogen waren, haben wir eine Form von *Tichothecium pygmaeum* gefunden, welche in manchen Merkmalen vom Typus abweicht, aber auch nicht ohne weiteres in eine beschriebene Varietät gestellt werden kann. Anderseits sind die Unterschiede zu gering, um eine eigene Art zu begründen. Wir ziehen es deshalb vor, die Form hier einfach zu beschreiben und sie vorderhand als eine vom Typus etwas abweichende Ausbildungsform zu betrachten.

Die dem Substrat eingesenkten oder auch manchmal aufsitzenden und mehr oder weniger oberflächlichen Fruchtkörper sind kugelig, 70-110 μ gross und am Scheitel mit einer zylinderischen, meist ziemlich hohen Mündung versehen. Diese ist innen von schräg nach aufwärts gerichteten, zartwandigen, etwas gestreckten Zellen ausgefüllt; nur zu innerst lassen sie einen engen Kanal frei. Aussen sind die Fruchtkörper von hellen, hyphigen Haaren bekleidet. Die Fruchtkörperwand besteht aus ein bis zwei Schichten von mehr oder weniger kugeligen, nicht sehr derbwandigen, 5-8 μ grossen, graubraunen Zellen. Die breit ellipsoidischen oder breit keuligen Asci sind 40-50 x 16-20 μ gross, sehr dickwandig und sie enthalten zahlreiche, (meist über 30) regellos den Inhalt erfüllende, ellipsoidische, hell rauchfarbene, 8-10 x 4-5 μ grosse, in der Mitte septierte Ascosporen. Die Asci sind von spärlichen fädigen, etwas zelligen Paraphysen umgeben.

Fundort : auf alter Rinde von *Salvadora oleoides* Dcne. —Pakistan, Lahore. Changa Manga, 19-10-1958, leg. S. Ahmad.

Was diese Form vor allem von den europäischen Materialien unterscheidet sind die nicht dunkelbraun sondern hell rauchfarbenen Ascosporen

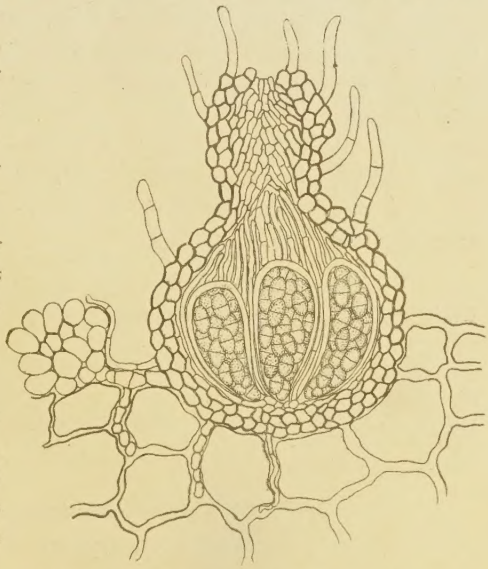

Abbildung 3. Schnitt durch Fruchtkörper von *Tichothecium pygmaeum*, Vergr. 500 X.

und die relativ kleinen Fruchtkörper mit verhältnismässig wenigen Asci.

26. **Cochliobolus sporoboli** E. Castell.

Auf altem Material einer *Sporobolus*-art haben wir auch einen pseudosphaerialen Ascomyceten gefunden, welcher sich durch im Ascus gedrehte, spindelförmige Ascosporen auszeichnet, wie sie für die Gattung *Cochliobolus* Dreschler typisch sind. Tatsächlich ist auch eine Art aus dieser Gattung bekannt geworden, welche auf *Sporobolus affinis* A. Rich. und *Sporobolus Ruspolianus* Chiok. parasitiert und, welche nach der ausführlichen, durch gute Abbildungen belegten Beschreibung mit unserer Form übereinstimmt. Es handelt sich um *Cochliobolus sporoboli* E. Castell. (Castellani, 1951).

Nach Castellani (1951) geht der Ascusform (auf abgestorbenen Pflanzenteilen) eine parasitische Konidienform aus der Formgattung *Helminthosporium* voraus; auf unserm Material war diese leider nicht mehr festzustellen. Der Pilz sei aber trotzdem kurz beschrieben:

Die dem Substrat eingesenkten, einzelstehenden, doch oft in Reihen angeordneten Fruchtkörper sind kugelig, zuweilen aber auch etwas niedergedrückt, 150-300 μ gross, am Scheitel mit einer kurzen konischen, innen von einem unregelmässig rundlichen Kanal durchbohrten Mündung versehen und oft aussen mit hyphigen Borsten besetzt. Die Wand ist aus mehr oder weniger rundlichen Zellen aufgebaut und die schwach keuligen, 90-140 x 12-14 μ grossen, bitunikaten Asci enthalten je acht fädige, mit 4-6 Quersepten versehene, gelbliche, 100-140 x 4-6 μ grosse, etwas gedrehte Ascosporen. Paraphysoiden sind vorhanden; sie sind fädig und hyalin.

Fundort: auf alten Halmen von *Sporobolus marginatus* Hochst— Pakistan, Lahore, 13-2-1956. leg. S. Ahmad.

Die ursprüngliche Beschreibung beruht auf Material, welches in Ostafrika gesammelt worden ist; der nunmehrige Fund aus Pakistan könnte darauf hindeuten, dass *Cochliobolus sporoboli* auch anderwärts mit Arten aus dieser Gattung vergesellschaftet gefunden werden dürfte.

27. **Holwaya salicis** nov. spec.

Auf Rinde von Salix haben wir einen hervorbrechenden, dunklen, hornartigen, gestielten Discomyceten mit fädigen Ascosporen gefunden.

Habituell erinnert er an Arten aus der Gattung *Encoelia* (Fr.) Karst.; die Sporen stimmen aber nicht mit deren Umschreibung überein. Hingegen passt der Pilz gut in die Umschreibung der Gattung *Holwaya* Sacc. und wurde deshalb mit deren Typusart *Holwaya leptosperma* (Peck) Durand (Nannfeldt, 1932 meist unter dem nomenklatorisch anfechtbaren Namen *Holwaya gigantea* (Peck) Durand bekannt) verglichen. Es ergab sich dabei, dass die beiden Pilze wirklich gattungsgleich sind; hingegen bestehen doch erhebliche Differenzen, welche es rechtfertigen, den Pakistanischen Pilz als eigene Art zu beschreiben. Vor allem sind seine Fruchtkörper viel kleiner als diejenigen der Typusart und vermehrt an den Stielteilen zusammengewachsen. Die Asci sind keulig, die Ascosporen liegen im Ascus meist deutlich gedreht und sie sind nur in der Mitte septiert, während *Holwaya leptosperma* zylinderische Asci mit parallel liegenden, vielfach quersepten Ascosporen besitzt.

Holwaya leptosperma besitzt eine Stilbaceen-artige Nebenfruchtform welche von Fries (1821) als *Crinula caliciiformis* beschrieben worden ist. Später wurde der Gattungsname *Crinula* auch für die Hauptfruchtform angewendet (z. B. Juel, 1922). Bei unserer neuen Art konnten wir auf dem vorliegenden Material noch keine Nebenfrucht form mit Sicherheit nachweisen. Es lassen sich zwar spärlich schnabelartige Gebilde ähnlich den Stielteilen von Stilbaceen erkennen, doch fehlen Fruktifikationsorgane, weshalb die Frage der Nebenfruchtform für diesen Pilz noch offen gelassen werden muss. Der Pilz lässt sich folgendermassen beschreiben :

Holwaya salicis nov. spec.

Apothecia sub cortice nascentia, erumpentia, solitaria vel aggregata et saepe confluenta, fusca, partibus ascophoris rotundato-discoidea, 350-500 μ diam. Lateraliter excipulum 20-25 μ crassitudine, fuscum, cellulis elongatis, crasse tunicatis, ordinibus stratis divergentibus compositum. Base excipulum formans stipes, hyphis regulariter textis (textura intricata) compositum et sub hypothecio textura oblita formans. Hypothecium indistincte formans hyphis hyalinis parallelis compositum. Asci paralleli, clavati, unitunicati, stipitati 100-120 x 14-16 μ, 8-spori, paraphyses numerosae, hyalinae in partibus superioribus ramosae circumdatae, Sporae filiformae, hyalinae, medio septatae, in ascos regulariter spiraliter convolutae, 60-75 x 4-5 μ.

Hab. in corticem *Salicis* sp.—Pakistan, Shogran, 28.7.1956, leg.

S. Ahmad, sub Nr. 14096.

Die Apothecien des Pilzes werden unter der Rinde angelegt und brechen dann einzeln oder meist gruppenweise und an den Stielen such vielfach zusammengewachsen hervor. Sie sind dunkel gefärbt, knorpelig, im fertilen Teil rundlich-scheibenförmig mit einem Durchmesser von 350-500 μ. Sie sitzen auf einem manchmal ästigen, bis 800 μ hohen Stiel. Das Excipulum besteht lateral (im Bereich der Fruchtschicht) aus gestreckten, derb-und dunkelwandigen, 8-15 μ langen, in

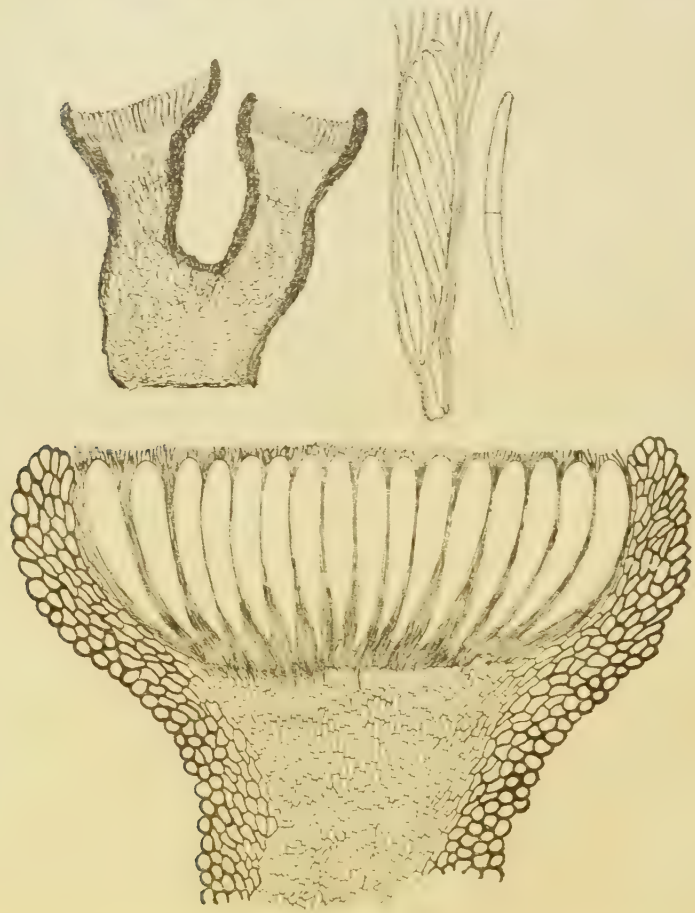

Abbildung 4. *Holwaya salicis*, oben links: Schnitt durch ein Stroma (schematisiet) Vergr 50 X. rechts: Ascus und Ascospore, Vergr. 1000 X. unten: Schnitt durch ein. Apothecium, Vergr. 250 X.

sich nach aussen richtende Schichten geordneten Zellen; es ist hier 20-25 μ dick und dunkelbraun gefärbt. Dieser Teil des Excipulum setzt sich nach unten als dunkle Rindenschicht des sonst hellbraun gefärbten Stielgewebes fort; es wird aber allmählich dünner und verliert sich immer mehr im übrigen Gewebe. Im Innern des hypostromatischen Fusses ist das Gewebe aus eng ineinander verschlungenen, zartwandigen, hyalinen Hyphen aufgebaut (textura intricata), während unmittelbar unter dem Hypothecium diese Zellen senkrecht parallel angeordnet sind (textura oblita). Das Hypothecium selber besteht aus sehr zartwandigen, dünnen, fädigen Zellen und es geht ohne wahrnehmbare Grenze in die Fruchtschicht über. Die parallel nebeneinander stehenden Asci sind keulig, 100-120 x 14-16 μ gross, unitunicat und am Scheitel mit einem einfachen Apikalapparat versehen. Sie enthalten acht fädige etwas gedreht, liegende, in der Mitte septierte, 60-75 x 4-5 μ grosse hyalinen Ascosporen. Die Paraphysen sind sehr zart fädig, oben vielfach septiert und die Asci deutlich überragend, wobei sie ein deutliches Epithecium bilden.

28. **Trematosphaeria verrucosa** nov. spec.

Als *Trematosphaeria indigoferae* haben wir erst kürzlich (Müller und Ahmad, 1958) einen auf abgestorbenen Zweigen von *Indigofera gerardiana* Wall. wachsenden Ascomyceten beschrieben und abgebildet. Ein in mancher Beziehung ähnlicher Pilz haben wir nun auf altem, geschnittenem Holz gefunden; er weicht aber doch erheblich von *Trematosphaeria indigoferae* ab, ebenso konnten wir ihn mit keiner sonst noch beschriebenen *Trematosphaeria*-art identifizieren, sodass auch dieser Pilz als neue Art beschrieben werden soll.

Diese Form zeichnet sich besonders durch die Sporen aus. Diese sind allerdings in ihren Grössenverhältnissen von *Trematosphaeria indigoferae* nicht stark verschieden, hingegen sind sie meist zweizellig und nur vereinzelt findet man auch vierzellige Exemplare und sie sind in reifen Zustande vor allem aussen sehr deutlich mit zahlreichen Warzen skulptiert. In diesem Merkmal unterscheiden sie sich auch vor allem von *Trematosphaeria pertusa* Fuck., welche in Bezug auf die Septierung ähnliche Sporen besitzt, welche aber bleibend glatte wände haben.

All diese drei erwähnten Formen zeigen auch im Aufbau ihrer Fruchtkörper eine gewisse Verwandtschaft mit Arten aus der Gattung *Otthia* Nitschke, besonders mit *Otthia lisae*(de Not.) Sacc. (vgl. Scheinpflug, 1958). Auch diese Art besitzt breit spindelförmige, lange

hyalin bleibende und sich später nur schwach anfärbende Ascosporen und auch sie weist derbe, im obern Teil aus rundlichen und unten aus gestreckten, in Reihen angeordneten Zellen aufgebaute Fruchtkörperwände auf.

Trematosphaeria verrucosa nov. spec.

Perithecia superficialia, hypostromatia, irregulariter tuberosa, solitaria vel aggregata et confluentia, 300-500 μ diam., apicaliter ostiolo atypico aperta. Paries 60-80 μ crassitudine, cellulis rotundatis, crasse tunicatis compositus. Asci clavati, bitunicati, 110-130 x 19-24 μ, paraphysoides cellulatae circumdati, 8-spori. Sporae fusoideae, 28-34 x 8-9 μ, primo hyalinae at medio septatae, demum subfuscae et rare triseptatae, episporis crassis, verrucosis circumdatae.

Hab. in ligno—Pakistan. Lun Bagla, 6.9.1955, leg. S. Ahmad, (sub Nr. 14018).

Die rasig, seltener auch einzeln oberflächlich, auf einem krustigen, aus ein bis vier Lagen von rundlichen, derbwandigen, braunen Zellen bestehenden, zum Teil eingewachsenen Hypostroma wachsenden Fruchtkörper sind unregelmässig knollig, braun, 300-500 μ gross. Am Scheitel besitzen sie eine durch anfänglich zartwandigere Fruchtkörperwändzellen angedeutete, hellere Stelle, welche später ausbröckelt und eine unregelmässig rundliche Mündung frei gibt. Die Fruchtkörperwand ist derb, 60-80 μ dick und aus rundlichen, im untern Teil kubischen, aussen sehr derbwandigen, dunkelbraunen, innen zarterwandigen und hellern, 8-15 μ grossen Zellen aufgebaut. Gegen die Basis zu sind Zellen in deutliche, von der Basismitte aus divergierende Schichten geordnet. Der Fruchtkörper selber sitzt entweder unmittelbar dem Hypostroma auf oder er ist mit einem fussartigen Basalstroma mit dem Hypostroma verbunden.

Die keuligen, derb—und doppelwandigen, 110-130 x 19-24 μ grossen Asci sind von einem aus zelligen, hyalinen Fasern bestehenden, paraphysoiden Geflecht umgeben. Die zu je acht im Ascus sitzenden Sporen sind breit spindelig, 28-34 x 8-9 μ gross, anfänglich lange hyalin und nur in der Mitte septiert, in jeder Zelle jedoch zwei deutlich getrennte Plasmapartien aufweisend, später sich allmählich braun färbend und deutlich warzig skulptiert und dazu zuweilen in jeder Zelle noch mit einer sekundären Querwand unterteilt.

29. **Stibocrea macrostoma** (Berk. et Curt.) v. Höhn.

Die bisher monotypische Gattung *Stilbocrea* Pat., mit dem Typus *Stilbocrea macrostoma* (Berk. et Curt). v. Höhn. gehört offensichtlich zu den Hypocreaceen. Von der ebenfalls Arten mit zweizelligen Sporen umfassenden Gattung *Hypocrea* Fr. unterscheidet sie sich durch die nicht in ihre Teilzellen zerfallenden Sporen und vor allem durch die hornartig den Stromata aufgewachsenen Stilbaceen-artigen Nebenfruchtform. *Stilbocrea macrostoma* (Berk. et Curt.) v. Höhn. [Synonym: *Stilbocrea Dussii* Pat.) kommt auf Rinde verschiedener Bäume in tropischen und subtropischen Regionen vor, scheint aber ziemlich selten zu sein. Das Material aus Pakistan hat Rinde von *Morus alba* L. als Wirt. Der Pilz lässt sich folgendermassen beschreiben :

Die rötlichen, 1 bis 10 mm grossen, rundlichen, verlängerten oder meist ziemlich unregelmässig begrenzten Stromapolster sind am Grunde in einen zentralen Stiel zusammengezogen und mit diesem im Substrat verankert. Innen sind sie aus vielfach verwobenen, 3.5-4.5 μ dicken, zelligen, hyalinen oder schwach rötlichen Hyphen zusammengesetzt. Aussen sind sie etwas höckerig und von den durchbrechenden Perithecienmündungen fein punktiert. Die Perithecien sind flaschenförmig, vollständig dem Stroma eingesenkt, bis 150 μ breit und bis 230 μ hoch und am Scheitel mit einer breiten, zylinderischen, oben bis an den Rand des Stromas vorstossenden Mündung versehen. Diese ist innen von einem deutlichen Kanal durchbohrt, welcher aber sehr dicht von feinen, fädigen, hyalinen Periphysen durchflochten ist. Die Fruchtkörperwand ist hell—fleischig und besteht aus mehreren Lagen von abgeflachten, 10-15 μ langen und 2-3 μ dicken, ziemlich zartwandigen Zellen.

Die dicht parallel nebeneinander stehenden, zylinderischen, zartwandigen Asci besitzen am Scheitel einen einfachen, sich mit Jod nicht färbbaren Apikalapparat. Paraphysen fehlen. Die zu je acht einreihig angeordneten Ascosporen sind ellipsoidisch, in der Mitte septiert und wenig eingeschnürt, 9-12 x 5-6 μ gross, hyalin, aussen fein höckerig skulptiert und überdies von einer schmalen Schleimhülle umgeben.

Die als *Stilbum Daphnopsidis* Pat. beschriebene Nebenfruchtform wird an denselben Stromata gebildet. An 100—150 μ dicken und bis 500 μ langen Stielen werden halbkugelige Köpfchen gebildet und an deren Aussenfläche an kurzen, fädigen Konidienträgern einzellige,

ellipsoidische, hyaline, 5-7 x 2-3 μ grosse Konidien einzeln abgeschnürt.

Fundort: auf Rinde von *Morus alba* Linn.—Pakistan, Lahore, Changa Manga, 19.10.1958, leg. S. Ahmad, sub. Nr. 14262.

30. **Coccostroma capparidis** (Mundk. et Ahmad) Müller et Ahmad

Auf abgestorbenen Zweigen von *Capparis aphylli* Roth. haben wir einen Ascomyceten mit oberflächlichen, mit einem hypostromatischen Fuss dem Substrat eingesenkten Stromata gefunden, welcher einzellige, hyaline Ascosporen besitzt und eindeutig sphaerial gebaut ist. Dieser Pilz ist sicher identisch mit dem von Mundkur und Ahmad (1946) als *Bagnisiopsis capparidis* beschriebenen Pilz, welcher später von Ahmad (1948) auf Grund der Auffassung von Dr. J. H. Miller in die Gattung *Penzigia* Sacc. gestellt worden ist. Nach der Bearbeitung der amerosporen Pyrenomycetengattungen von v. Arx und Müller (1954) kommt aber als Gattung nur *Coccostroma* Theiss. et Syd. in Betracht, zu der *Bagnisiopsis* Theiss. et Syd. synonym ist. Der Pilz weicht allerdings in verschiedenen, allerdings nicht sehr wichtigen Merkmalen von den bisher bekannt gewordenen Arten der Gattung ab. Einmal kommt sie auf abgestorbenen Zweigen vor, während die bisher bekannt gewordenen Arten auf lebenden Blättern zur Reife gelangen. Immerhin deutet die Art des Vorkommens deutlich auf einen Parasiten hin. Dann bildet der Pilz in denselben Stromata wie die Hauptfruchtauch eine Nebenfruchtform aus, welche wohl einen ähnlichen Bau zeigt wie für verschiedene *Coccostroma*-arten nachgewiesene *Hemidothis* Syd., sich aber durch die nicht fädigen sondern kleinen ellipsoidischen Konidien deutlich unterscheidet. In der Ausgestaltung der Stromata und Perithecien stimmt aber unser Pilz gut mit den übrige Arten der Gattung überein.

Die Gattung *Coccodothis* Theiss. et Syd. umfasst eine grössere Zahl von Arten, welche wegen der äussern Ausgestaltung ihrer Stromata in eine ganze Anzahl verschiedener Gattungen gestellt worden sind (vgl. Arx und Müller, 1954). Am häufigsten wurde *Bagnisiopsis* Theiss. et Syd. verwendet und unter diesem Namen sind die Formen auch zweimal monographisch bearbeitet (Petrak, 1928; Miller und Burton, 1943). Die meisten bisher bekannt gewordenen Arten stammen aus Südamerika; auch in Bezug auf ihre Verbreitung passt demnach unsere Art nicht durchwegs zu den übrigen Vertretern. Dazu ist allerdings zu sagen, dass wir wenig über die tropischen Pilze wissen und Spekulationen über deren Verbreitung demnach verfrüht sind.

Die Gattung *Penzigia* Sacc. emend. Petch (vgl. v. Arx und Müller, 1954) gehört zu den Xylariaceen. Sie besitzt Asci mit einem sich mit Jod blau anfärbenden Apikalappart und braune Ascosporen; beides trifft für den vorliegenden Pilz nicht zu.

Coccostroma capparidis (Mundk. et Ahmad) Müller et Ahmad

Synonyme: *Bagnisiopsis capparidis* Mundkur et Ahmad, Commonw. Myc. Instit. Mycological Paper 18, 1 (1946).

Penzigia capparidis (Mundkur et Ahmad) Ahmad, Sydowia 2, 73 (1948).

Matrix: dürre Aestchen von *Capparis aphylli* Roth. (Indien, Pakistan)

Hab. in ramis emortuis *Capparis aphylli* Roth—Pakistan, Lahore, Changa Manga, 27.3.1954. leg. S. Ahmad sub Nr. 9059 .

Der Pilz auf dem Substrat oberflächliche, dunkle halbkugelig—knollenförmige, unregelmässig höckerige Stromata mit einem Durchmesser bis 1200 μ. Unten sind sie deutlich zusammengezogen und in einen, dem Wirtsgewebe eingesenkten Stiel verengert. Dieser ist deutlich plectenchymatisch aufgebaut und besteht aus zahlreichen parallelen, senkrecht gestellten Reihen von bis 20 μ langen und bis 10 μ breiten, mehr oder weniger kubischen, hyalinen oder gelbbräunlichen Zellen. Im Wirtsinnern verbreitert sich dieser hypostromatische Fuss und wird zu einem kompakten Geflecht aus hyphigen, sich eng ineinander verschlingenden, hellen, zum Teil auch rundlichen Zellen. Dieses wirtsinterne Stroma drängt sich zwischen den Leitungsgeweben, welche nicht vom Pilz durchwuchert werden, in die innern Gewebepartier und löst sich dort allmählich in ein lockeres Hyphengeflecht auf, welches die Mesophyllzellen durchwuchert. Auch seitlich dringt das Stroma unter der Epidermis, zum Teil auch in deren Zellen über weite Strecken in den Wirt und bildet hier ein kompaktes, unregelmässig dickes Polster, nur hier und da durch die Stomata nach aussen dringend und kleine, hyaline Stromahöckerchen bildend.

Im oberflächlichen fertilen Stroma divergieren die im Fussteil senkrecht gestellten Zellreihen nach allen Richtungen, die Zellen werden allmählich grösser und breiter und zuletzt mehr oder weniger rundlich. Sie bleiben aber hell und ziemlich zartwandig. Nur aussen bildet sich eine dunkle Kruste von 20-30 μ Dicke. Sie besteht aus rundlichen, sehr derbwandigen (bis 3 μ dick) olivenbraunen, 12-18, bisweilen bis 25 μ grossen Zellen.

An einzelnen Stellen weniger Stromata bildet sich zunächst die Nebenfruchtform aus. In kammerigen, oben offenen, manchmal aber auch geschlossenen, senkrecht ellipsoidischen Höhlungen von verschiedener Grösse (meist aber 80-150 μ Durchmesser) bilden sich aus senkrecht prosenschymatischen Wandgewebe heraus die dicht nebeneinander stehenden, fädigen, oft schleimig verklebten, 10-20 μ langen Konidienträger, an denen einzellige, kugelige oder ellipsoidische Konidien von 1-1,5 μ Grösse abgeschnürt werden.

Die übrigbleibenden Stromapartien enthalten die meist nur wenigen—selten mehr als 10—Perithecien. Diese sind mehr oder weniger kugelig, 150-250 μ gross und sie durchbrechen am Scheitel mit einer konischen, innen von einem reich periphysierten Kanal durchbohrten Mündung die äussere Stromakruste. Die helle Fruchtkörperwand besteht aus zahlreichen Lagen von aussen prismatischen, innen stark zusammengepressten und dünnwandigen, 10-15 μ langen Zellen. Die sehr zahlreich der innern Wand entlang angeordneten, zylinderischen oder meist keuligen Asci sind zartwandig, am Scheitel mit einem einfachen Apikalapparat versehen, 30-40 x 3,5-4,5 μ gross und sie enthalten acht einzellige, hyalin, ellipsoidische, 4-5 x 2-2,5 μ grosse Ascosporen. Die zahlreichen Paraphysen verschleimen vor der Reife.

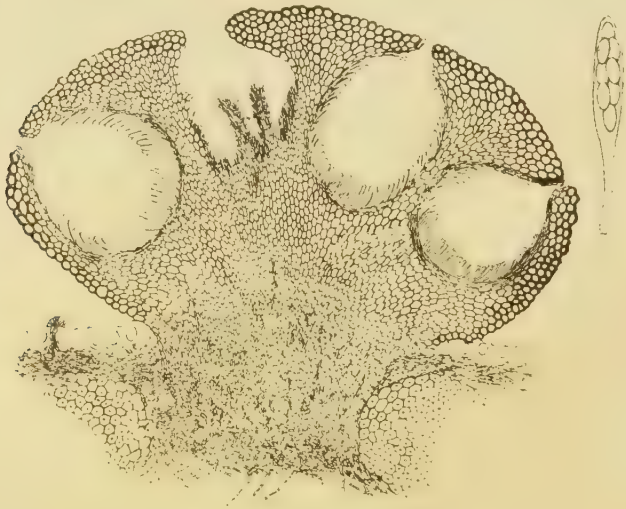

Abbildung 5. Schnitt durch ein Stroma von *Coccostroma capparidis*. Im Zentrum: Konidienform, seitlich: Perithecien, Vergr. 125 X. rechts Ascus mit Sporen Vergr, 1000 X.

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Reconstruction of the genus *Trichuris*, and a short review of its taxonomy and morphology

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INTRODUCTION

At least 64 species have so far been recorded under the genus *Trichuris*, and these have been found in the Marsupialia and the eutherian orders Artiodactyla, Carnivora, Rodentia, Insectivora, and Primates. Quite obviously, the genus has become too unwieldy for taxonomic study. At the same time, no attempt has been made so far at evaluating the relative importance of the characters proposed from time to time for the taxonomic differentiation of the species. Such characters have, in almost all cases, been based on a restricted material involving only a few species. It was in view of this unsatisfactory position that the work was taken up under the guidance of Professor J. J. C. Buckley, and the author is extremely grateful to the Professor for the advice and the interest shown by him during the course of these studies. The author is also grateful to the authorities of the British Museum (Natural History) for their cooperation in allowing him to consult the library and study the *Trichuris* material available at the Museum. The author feels much indebted to Professor J. G. Baer, Institute of Zoology, Neuchatel, for making available some *Trichuris* material and offering full facilities for study and discussion. The author is also grateful to Professor M. Abdussalam, College of Animal Husbandry, Lahore, for encouragement.

HISTORY

The following early historical account is an extract from Dujardin (1845) :

The *Trichuris* of man was described for the first time by Morgagni (*Epistolae anatomicae* Patav. 1764, *in folio*). Roederer & Wagler (1761-1762) mentioned the *Trichuris* of man in connexion with the disease they named *morbus mucosus* and in cases of this disease they found the worms in carcases on autopsy. However, they mistook the anterior filiform portion for the tail and thus named it *Trichuris*. Goeze (1782) rectified this error and renamed the worms as *Trichocephalos*. Goeze, at the same time, described two more *Trichuris* worms, one from the

mouse and the other from the wild boar. The name *Trichocephalos* was adopted (after its emendment to *Trichocephalus*) by Schrank, Gmelin and Rudolphi. Zeder (1803) proposed the name *Mastigodes* for the genus. Rudolphi in his *Entozoorum Hist. nat.* in 1809, described nine species under the genus, and later, three of these were shifted to trichosomes and *Sclerotrichum.* In his synopsis of 1819, Rudolphi added another species *(T. palaeformis)* to the genus. Creplin (1825) in his *Observationes de Entozois* claimed that *Trichuris crenatus* (from pig) of Rudolphi is identical with *Trichuris dispar* (from man). He, at the same time, rectified an error by Rudolphi. The latter believed the vulva to be situated near the anus at the posterior extremity. Creplin, on the other hand, described it to be near the commencement of the thick posterior portion.

CLASSIFICATION. *Trichocephalos* (*Trichuris*) is the third genus of the order Nematoidea of Rudolphi.

Railliet (1895) treated the genera *Trichocephalus*, *Trichosoma* and *Trichinella* under the family Trichotrachelidae.

Ransom (1911) erected the new subfamilies Trichurinae and Trichinellinae under the family Trichinellidae Ward, 1907, and placed the genera *Trichuris* and *Capillaria* in the subfamily Trichurinae. After the creation of the family Trichuridae Railliet, 1915 and the subfamily Capillariinae Railliet, 1915, the genus *Trichuris* was left alone under the subfamily Trichurinae. The family Trichuridae was subsequently placed by Railliet (1916) under the superfamily Trichuroidea.

Ward (1917) divided the nematodes into two subclasses, viz., those with a capillary oesophagus under Trichosyringata and the others with a muscular oesophagus in Myosyringata. The genus *Trichuris* was consequently placed under the subclass Trichosyringata.

Chitwood (1933) divided the class Nematoda into two subclasses, namely Phasmidia and Aphasmidia. They listed Strongylata, Ascaridata and Spirurida under Phasmidia, and the Trichuroidea-Mermithoidea group and Dioctophymata under the subclass Aphasmidia. Under Trichuroidea they placed three families, namely, Trichuridae (Trichurinae, Capillariinae, Trichosomoidinae), Trichinellidae and Cystoopsidae.

Neveu Lemaire (1936) recognized the subclass Trichosyringata in preference to Aphasmidia and placed the superfamily Trichuroidea under the order Trichurata. He created, at the same time, the family

Capillariidae and thus left the genus *Trichuris* alone under the family Trichuridae.

Roman (1949) suggested that, on the basis of organization of the internal genitalia, the genera *Trichuris* and *Capillaria* should be grouped under the family Trichuridae and the genera *Trichinella* and *Trichosomoides* under Trichinellidae. This arrangement is in accordance with that of Neveu Lemaire (1936).

Another classification, which is mainly favoured by Russian workers, is based on the acceptance of the genus under the name of *Trichocephalus*. Under this arrangement the genus *Trichocephalus* Schrank, 1788 is treated alone under the subfamily Trichocephalinae Ransom, 1911 and the family Trichocephalidae Baird, 1853. The family along with Capillariidae Neveu Lemaire, 1936, Trichinellidae Ward, 1907 and Trichosomoididae Yorke & Maplestone, 1926, is placed under the superfamily Trichocephaloidea Spassky, 1954.

MORPHOLOGY. Mayer (1841) was the first to give a detailed description of genital organs and published characteristic drawings of the spicule and sheath of *Trichuris ovis*.

Wilson (1846) described the anatomy of *Trichuris ovis* and supplemented his description with whole mount drawings of the male and female specimens. Cobbold (1864) rendered a detailed drawing of the hind end and copulatory organs of the male *Trichuris ovis*. The description and drawings of *T. ovis* by Ransom (1911) also provide useful information.

A detailed account of the anatomy of *Trichuris trichiura*, under the names of *T. dispar* and *T. crenatus*, respectively, was published by Eberth (1860) and Rauther (1918). Schneider (1866) studied the material from man and other Primates and reached the conclusion that the whipworms from the two sources are identical. Schwartz (1926) studied the material from man, chimpanzee, *Cercopithecus* and swine and confirmed the view, expressed by Creplin and shared by Leuckart, that whipworms from swine, man and Primates are identical.

Sprehn (1927) reviewed the literature on *Trichuris* from ruminants and after a study of the material from Germany and the Zoological Museum, Berlin, he concluded that *Trichuris globulosa*, until then known from camel only, was quite common in sheep and goats. Sprehn (1927) redescribed both *T. globulosa* and *T. ovis* and emphasised the importance of the differences in the sheath and spicule of the species.

Fülleborn (1923) showed that the first stage larvae of *Trichuris trichiura*, *Trichinella spiralis* and *Trichosomoides crassicauda* have distinct stylets. Küchenmeister (1857) and Li (1933) described a stylet in *T. trichiura*. Shaikhobalova (1947) demonstrated a stylet in *Trichuris muris* and Chitwood & Chitwood (1950) reported to have seen it in *Trichuris vulpis*.

Chandler (1930), on account of the variability of the shape of the spicular sheath and its spiny armature, studied the internal genitalia in six species of the genus and concluded that the relative size of internal genitalia could be employed as a reliable character in the differentiation of species of this genus.

Baylis (1932) described the shape and structure of vagina in *T. ovis* and *T. globulosa* and found constant differences. He expressed the opinion that the character of vagina would enable a specific determination to be made in the two species. However, he neither suggested an application of this criterion in the taxonomic differentiation of other species of the genus, nor did he give any weight to it in the species which he described later on.

MATERIAL

The species which were studied by the author and the sources from which they were obtained, are detailed below :

T. trichiura, *T. nutria*, *T. muris*, *T. mettami*, *T. vulpis*, *T. peramelis*, *T. unguiculatus*, *T. ovis*, *T. skrjabini*, *T. globulosa*.	British Museum (Natural History) London
T. serrata, *T. spiricollis*, *T. trichiura*, *T. gazelle*, *T. cervicaprae*, *T. parvispicularis*, *T. marsupialis*, and material belonging to another two species which are new to Science.	London School of Hygiene & Tropical Medicine
T. tenuis, *T. fossor*	U. S. Department of Agriculture, Beltsville
T. discolor, *T. globulosa*, *T. skrjabini*, and material of one species which is probably new to Science.	Pakistan
T. hystricis, *T. baeri*	Institute of Zoology, Neuchatel

OBSERVATIONS

The author's observations have led him to the conclusion that the species described under the genus *Trichuris*, could be sharply divided

into two main groups, viz. (*a*) species showing well developed musculature in ejaculatory duct, and (*b*) species showing no noticeable muscles in ejaculatory duct but well developed musculature in cloaca.

The observation of other workers on this fundamental question are as follows.

T. ovis

The ejaculatory duct is shown as a strongly muscular organ in Wilson's (1846) whole mount drawings. Cobbold (1864) agreed with Wilson and quoted Wilson's observations as follows :

"At about the union of the anterior with the middle third of the abdomen, this sac contracts into a thick fleshy sphincter valve, and is there continued onwards as a *large tube, with thick and fleshy walls* (writer's italics) to near the extremity of the tail, where it becomes narrower, and terminates by a small opening in the intestine."

T. trichiura

Küchenmeister (1857) used the collective term spermatic duct or seminiferous organ for the portion constituted by seminal vesicle and ejaculatory duct. His description of the seminiferous organ from the region of the junction of seminal vesicle and ejaculatory duct, is as follows : "...this seminiferous organ contracts into *a very short, narrow, straight tube, which opens into the dilated muscular cloaca, with tolerably thick uniform walls,...*" (writer's italics).

The portion described as "a very short, narrow, straight tube" corresponds to the ejaculatory duct. In Küchenmeister's whole mount drawing (Plate VII, fig. 1) the seminal vesicle and ejaculatory duct are shown by simple lines while the cloaca is shown to have thick walls.

While describing the musculature of the abdominal region in *T. dispar*, Eberth (1860) indicated its location in the wall of the cloaca. He observed, "Aus der Muskulatur der Bauchgegend kommt nahe der Vereinigung des Duct. ejac. mit dem Darm ein Längsmuskelstrang, Fig. XI *h*, welcher anfangs aus zwei isolirten Hälften besteht und an die Wurzel des Spiculum geht. Seine Elemente sind sehr Zarte, lange, spindelförmige Fasern ohne weitere Structur.

Die Cloake Fig. XI *g*, enthalt schon von ihrem Anfange innerhalb der Muskellage noch 2 Hüllen.-es ist ein Bild, welches sehr an die Chitinhäute der Insecten erinnert."

Rauther (1918) made no mention of the presence of muscles in the ejaculatory duct of *T. crenatus* and described the presence of long epithelia on the inner side of the duct, as follows :

> "Der Ductus ejaculatorius ist besonders bemerkenswert dadurch, dass sein hohes Epithel einen Besatz von langen, zarten Fäden trägt; ob es sich um bewegliche Cilien handelt, mag sehr fraglich erscheinen; als Elemente eines, Stäbchensaumes" betrachtet befremdet aber an den Fäden die Länge, Zartheit und lockere Stellung. Jedenfalls bietet dieser Befund das Gegenstück zu dem indessen viel niedrigeren Saum des Epithels im homologen Teil des weiblichen Genitaltracts, dem Uterus; beide aber sind unter dem übrigen Nematoden ohne Analogie."

In addition to the character of ejaculatory duct and cloaca, the following other characters differentiate the two groups :

Description of character	*"trichiura"* group	*"ovis"* group
Location of anal and cloacal openings	subterminal	terminal
Stylet	present	absent
Size of vagina	short	at least three times as long as in *"trichiura"*
Cloaca	large and highly muscular	small and musculature less prominent than that of ejac. duct.
Junction of spermatic duct and seminal vesicle	much behind the junction of oesophagus and intestine	in proximity of the junction of oesophagus and intestine
Ratio of anterior filiform and posterior thick portions.	anterior portion less than twice as long as the posterior	anterior portion more than twice the length of posterior

Egg	opercula conform in length to the polar thickness of the egg envelope, presenting even contours externally and internally.	opercula very prominent, projecting well beyond the protein coat externally, and well into the cavity, internally.

Küchenmeister (1857) described the stylet in *T. trichiura* in the following words : "We often perceive, at the extreme tip of the head, the protrusion of a small, hyaline, onion-like structure, which passes off in an obtusely conical form anteriorly."

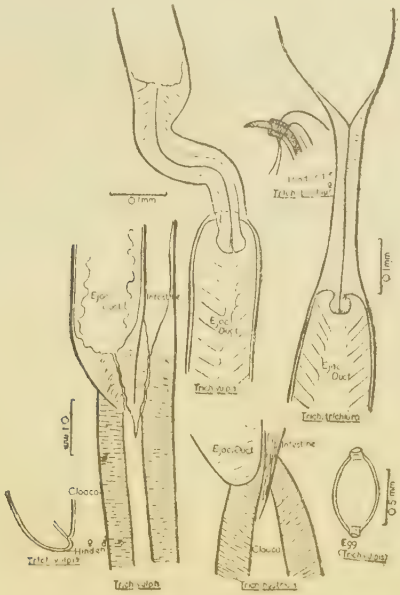


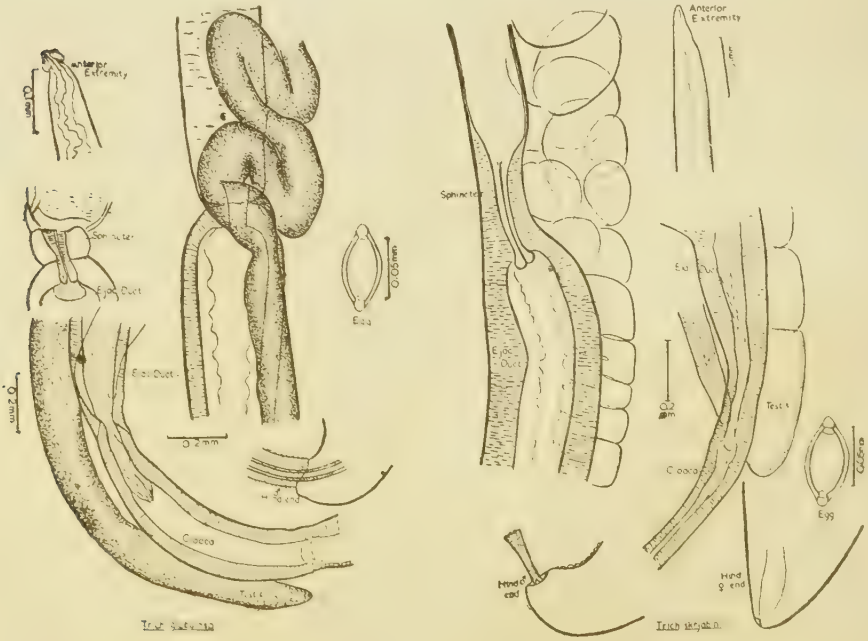
Fig: 1 Characters characterizing the subfamily Trichurinae.

The *"ovis"* group is subdivided into *"ovis"* group and *"skrjabini"* group on the basis of the following points :

Description of character	*"ovis"* group	*"skrjabini"* group
Relative size of ejac.	nearly equal	ejac. duct

duct and seminal vesicle	in length	nearly double the length of seminal vesicle
Caudal papillae in the male	absent	present
Vesicular enlargement at the head end	present	absent
Arrangement of testis	straight along the ejac. duct and convoluted along the seminal vesicle	convoluted throughout its course
Egg	outer surface smooth	outer surface granulous

The presence of a vesicular swelling near the head end, has been pointed out in several species. Wilson (1846) figured it and described



Figs: 2 & 3. Characters characterizing the subfamily Buckleyurinae

it in *T. ovis,* as follows : "Immediately below the point of the head the integument is raised from the surface beneath, and more or less distended, so as to constitute a prominent transparent collar." Neumann (1905) described it in the same species as follows : "this species has the head sometimes furnished with two transparent vesicular enlargements in the form of wings." Kreis (1935) indicated the presence of vesicular enlargements "Kopflappen" in *T. cervicaprae.* Likewise, the rough surface of the outer coat of eggs has been noticed in a number of species. Dujardin (1845) described the egg shell in *T. unguiculatus* as slightly granulous.

The "*trichiura*" group has been subdivided into "*trichiura*" and "*vulpis*" groups on the basis of relative size of internal genitalia. In "*trichiura*" group the cloaca and ejaculatory duct are nearly of equal size. On the other hand, the cloaca is many times longer than the ejaculatory duct in "*vulpis*".

As a result of these studies the groups designated as "*ovis*" "*skrjabini*" and "*vulpis*", are assigned to new genera. A new subfamily is proposed for the reception of the genera constituted by "*ovis*" and "*skrjabini*" groups and the rest of them, viz. "*trichiura*" and "*vulpis*" are retained in the subfamily Trichurinae.

Subfamily *TRICHURINAE* Ransom, 1911

Syn. Trichocephalinae Ransom, 1911

Trichuridae: anterior filiform portion not exceeding twice the length of posterior thick portion; head end furnished with a stylet; ejaculatory duct non-muscular but cloaca highly muscular and very prominent; cloacal and anal openings subterminal; vagina short; opercula of eggs conform in length with the polar thickness of the egg envelope, presenting even contours both externally and internally.

Genus **Trichuris** Roederer, 1761 "**trichiura**" group

Syn. *Trichocephalus* Schrank, 1788; *Mastigodes* Zeder, 1800.

Trichurinae: cloaca shorter or nearly of the same size as ejaculatory duct; a pair of caudal papillae in the male. Parasites of Insectivora, Marsupialia, Primates and pig.

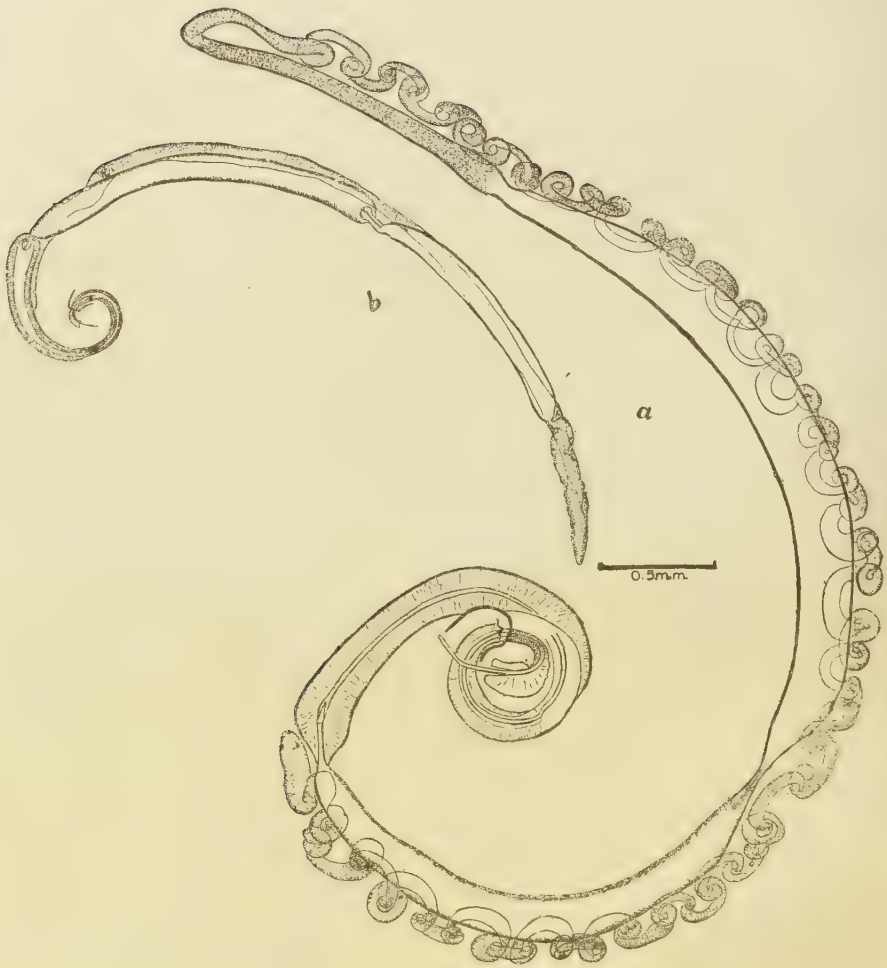


Fig: 4. Genitalia of a. *T. trichiura* and b. *T. marsupialia* characterizing the genus *Trichuris* sensu stricto.

The following species are included in the genus :

T. trichiura (Linn: 1767), *T. hystricis* Kreis, 1938, *T. nutria* (Schulz and Petrow, 1934), *T. muris* (Schrank, 1788), *T. meitami* Baylis, 1935, *T. modisonensis* Tiner, 1950, *T. opaca* Barker and Noyes, 1915, *T. perognathi* Chandler, 1945, *T. peromysci* Chandler, 1946, *T. cynocephala* Khera, 1951, *T. gracilis* (Rud: 1819), *T. infundibula* (Linstow, 1906), *T. fossor* Hall, 1916, *T. neotomae* Chandler, 1945, *T. peramelis* Baylis,

1932, *T. marsupialis* Foster, 1939, *T. urichi* Wolfgang, 1951, *T. reesali* Wolfgang, 1951, *T. minuta* (Rud. 1819).

Genus **Rudolphia** n. gen.

Trichurinae; cloaca many times longer than ejaculatory duct; caudal papillae in the male absent.
Parasites of Carnivores.

TYPE-SPECIES: *R. vulpis* (=*T. vulpis* Froelich, 1789)

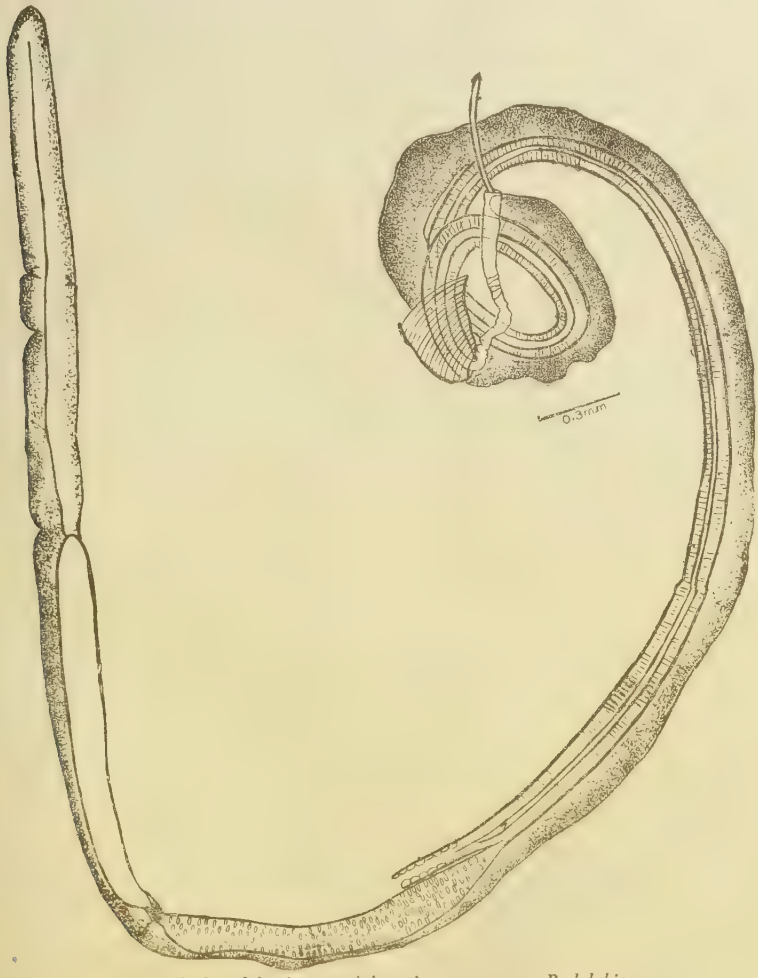


Fig: 7. Genitalia of *T. vulpis* characterizing the new genus *Rudolphia*.

Besides the type, the following species are included in the genus: *T. serrata* (Linstow, 1879), *T. concolor* (Burdelev, 1951), *T. campanula* (Linstow, 1899), *T. georgius* (Rodonaja, 1950).

Subfamily *BUCKLEYURINAE* n. subfam.

Trichuridae: anterior filiform portion exceeding twice the length of posterior thick portion; head end without a stylet; ejaculatory duct

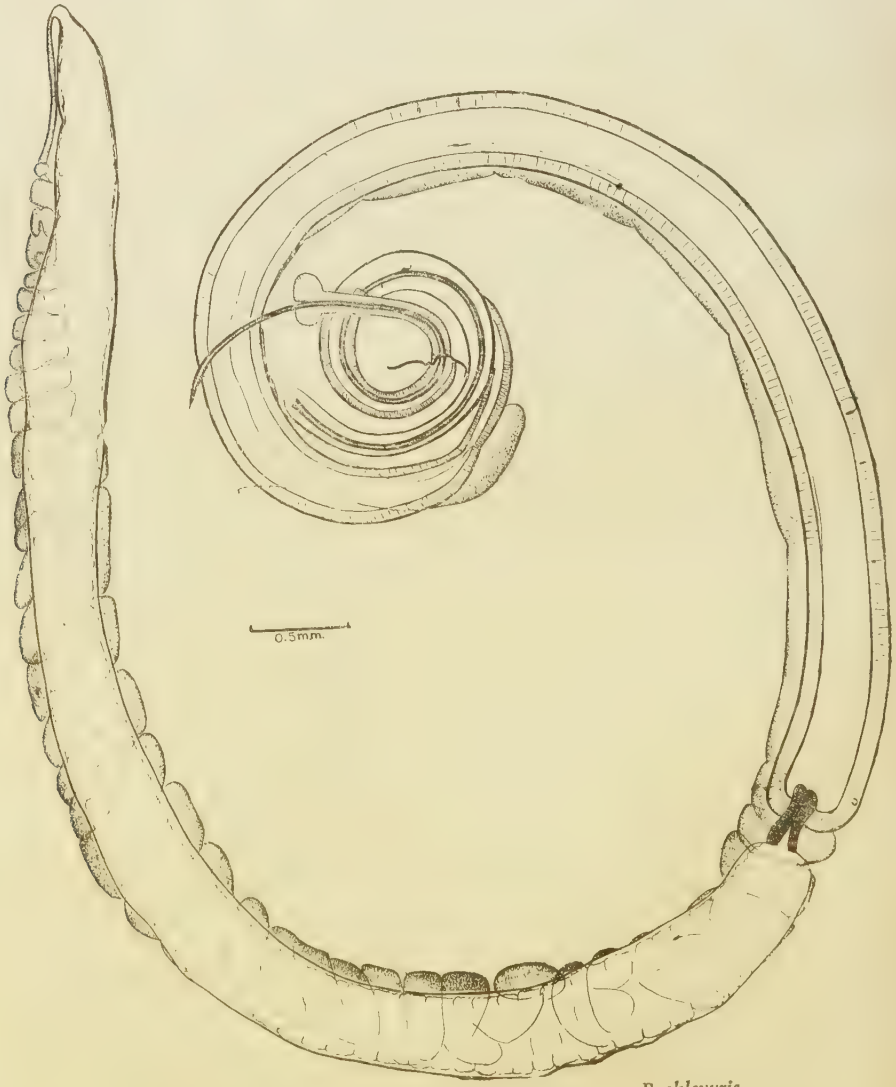


Fig: 5. Genitalia of *T. globulosa* characterizing the new genus *Buckleyuris*.

strongly muscular; cloaca short and less muscular than ejaculatory duct; cloacal and anal apertures terminal; vagina long; opercula of eggs very prominent and projecting beyond the protein coat externally as well as internally.

Parasites of ruminants and rodents.

Genus **Buckleyuris** n. gen.

Buckleyurinae: vesicular swelling present near the head end; ejaculatory duct and seminal vesicle nearly of equal dimensions; caudal papillae absent in the male; testis straight along the ejaculatory duct but convoluted along the seminal vesicle ; outer coat of egg shell smooth.

TYPE-SPECIES: *B. ovis* (=*Trichuris ovis* Abilgaard, 1795)

The following species are included in the genus:
T. globulosa (Linstow, 1901), *T. cervicaprae* Kreis, 1935, *T. barbertonensis* Ortlepp, 1937, *T. antidorcii* Ortlepp, 1937, *T. parvispicularis* Clapham, 1945, *T. vondwei* Ortlepp, 1938, *T. citelli* Chandler, 1945, *T. capreoli* (Artuch, 1948).

Genus **Salamia*** n. gen.

Buckleyurinae: vesicular swelling near the head end absent; ejaculatory duct much longer than the seminal vesicle; caudal papillae in the male present; testis convoluted throughout its course; outer surface of the egg shell granulous.

TYPE-SPECIES: *S. skrjabini* (=*T. skrjabini* Baskakov, 1924)

The following species are included in the genus:
T. leporis Froelich. 1789, *T. spiricollis* Solomon, 1932, *T. baeri* Sarwar, 1955, *T. unguiculatus* (Rud. 1809), *T. sylvilagi* Tiner, 1950, *T. discolor* (Linstow, 1906), *T. tenuis* Chandler, 1930, *T. gazelle* Gebauer, 1933, *T. parvispiculum* Ortlepp, 1937, *T. surka* (Garkavi, 1950)

DISCUSSION OF TAXONOMIC CHARACTERS

The taxonomic characters utilized for differentiation of *Trichuris* species, relate largely to the internal and external genitalia and the ratio of anterior to posterior portions of the body. The reliability of external genitalia is often held in doubt, on account of the presence of variations in the external genital organs in the species *T. trichiura*; but this variability has never been reported to occur, to any appreciable extent, in species other than *T. trichiura*. Under the new arrangement, it would appear

*In honour of Professor M. Abdussalam

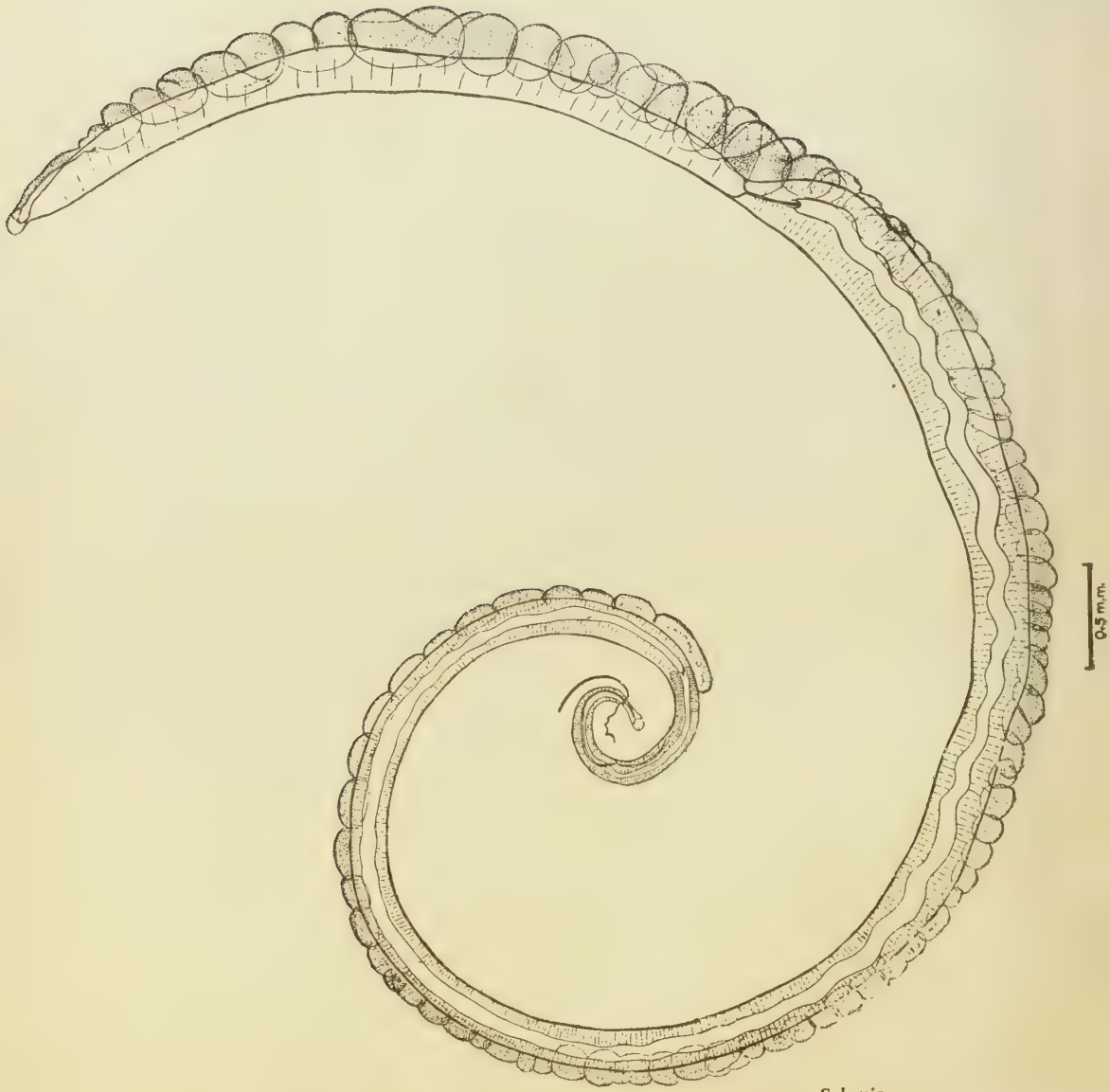


Fig: 6. Genitalia of *T. skrjabini* characterizing the new genus *Salamia*.

that the variability in the external genitalia is confined to the genus *Trichuris* sensu stricto. The character of internal genitalia and the ratio of anterior to posterior portion of the body, are reliable characters for generic differentiation and not for the differentiation of the species

as originally proposed. The size of the internal genitalia depends on the size of the posterior portion of the body and which, however, shows a good deal of variation in material from different sources in species, such as *T. ovis* and *T. globulosa*.

SUMMARY

The history of the genus *Trichuris* and its classification and morphological advancements have been briefly reviewed.

Three new genera, viz. *Rudolphia, Buckleyuris* and *Salamia* have been proposed, with types, respectively, as *R. vulpis, B. ovis* and *S. skrjabini*.

The reliability of taxonomic characters, so far proposed, is discussed.

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Further Contributions towards the Flora of Karachi.

S. M. H. JAFRI, Ph.D. (Edin).

In continuation of my previous paper, "Additions and corrections to the Flora of Karachi" [*Biologia*, iv : 10-24 (1958)], further information and new records for the area are recorded here in the present paper. There are 23 new records and 17 spp. needed nomenclatorial changes.

I am indebted to Dr S. I. Ali for informations provided regarding the genera *Indigofera*, *Astragalus* and *Tephrosia*.

1. *Bergia suffruticosa* (Delile) Fenzl in Dansk. Bot. Gesel. Reg., iii: 183 (1841).
   Syn: *Lancretia suffruticosa* Delile, Fl. Egypt, 69 (1812); *B. odorata* Edgew. in Journ. Asiat. Soc. Bengal, vii: 765 (1838).

2. *Abutilon glaucum* (Cav.) Sweet, Hort. Berol., i: 54 (1827).
   Syn : *Sida glauca* Cav., Icon., v: 8, t. 11 (1791); *S. mutica* Del., Fl. Egypt., 60, n. 45 (1812); *A. muticum* (Del). Sweet, l. c., ed. 2:65 (1830).

3. *Malvastrum coromendelianum* (L.) Garcke in Boupland., v: 297 (1857).
   Syn: *Malva coromendeliana* L., Sp. Pl., 687 (1753) ; *Malva tricuspidata* Ait., Hort. Kew., ed. 2, iv: 210 (1811); *Malvastrum tricuspidatum* (Ait.) A. Gray, Pl. Wright., 16 (1852).

   Malir, waste ground near cult. field, under shade, fls. yellow, common, 10-10-58 (No. 2523).

4. *Gossypium* sp.
   Malir Cantt., subsandy soil, forming scrub vegetation with other shrubs, fairly common, 8-7-58 (No. 2444).

It is a truly wild cotton species, having branches shooting up to a height of 10 ft.; corolla yellow with purple base, about 2 inches long; calyx truncate and epicalyx entire to toothed; capsules more or less beaked and seeds with copious cottony growth.

Identification of this species has not been possible from the present resources of literature, but it is hoped that it will be done soon with the help of Mr B. L. Burtt, who has collected enough material of it with me during November last, and its separate account will be published soon elsewhere.

This species seems to flower and fruit throughout the year under the climatic conditions of Karachi. The degree of pubescence on it varies according to the seasons.

This species is quite distinct from *G. stocksii* and *G. bakeri* reported from Sind.

5. *Corchorus olitorius* L., Sp. Pl., 529 (1753).
Malir, alluvial soil, in Papaya fields, 10-10-58 (No. 2517).

6. *C. tridens* L., Mantiss. App., 566 (1771).
Malir, river bed, alluvial soil, 10-10-58 (No. 2565); Landhi, subsandy soil, quite common, 10-10-58 (No. 2506).

7. *Zizyphus nummularia* (Burm. f.) Wt. and Arn., Prodr., 162 (1834).
Syn: *Rhamnus nummularia* Burm. f., Fl. Ind., 61 (1768); *Z. rotundifolia* Lam., Encyc., iii: 319 (1789).

8. *Cardiospermum halicacabum* L., Sp. Pl., 366 (1753).
Syn: *C. microcarpum* H. B. & K., Nov. Gen., v: 104 (1815). Drig Rd., stony hillock, common, 31-7-58 (No. 2478); Malir Cantt., subsandy soil, profusely growing in ditches, 28-11-58 (No. 2595).

9. *Crotalaria medicaginea* Lam., Encyc., ii: 201 (1786)
Malir, river bed, sandy and stony ground, rare, 10-10-58 (No. 2541); Mangopir.

10. *Cyamopsis tetragonoloba* (L). Taubert in Engler and Prantl., Natur. Pflanzenfam., iii (3): 259 (1894).
Syn: *Psoralea teragonoloba* L., Mantiss., i: 104 (1767); *Dolichos psoraleoides* Lam., Encyc., ii: 300 (1786); *C. psorlaeoides* (Lam.) DC., Prodr., ii: 216 (1825).

11. *Indigofera sessiliflora* DC., Prodr., ii : 228 (1825).
Syn: "*I. trigonelloides*" Auctt. not of Jaub. and Spach. The true *I. trigonelloides* J. & S. does not extend to the Indo-Pakistan subcontinent.

12. *I. hochstetteri* Baker in Oliver, Fl. Trop. Afr., ii: 101 (1871).
Syn: *I. anabaptista* Steud., Nom. Ed. 2: 805 (1840)-*nom nudum;* ex Baker in Fl. Brit. Ind., ii: 102 (1876).

13. *I. oblongifolia* Forsk., Fl. Aegypt-Arab., 137 (1775).
Syn: *I. paucifolia* Del. Fl. d'Egypt, 251 (1812).

14. *Tephrosia strigosa* (Dalz). Sant. and Mahesh. in Journ. Bomb. Nat. Hist Soc., 54 (3): 805 (1957).

Syn: *Macronyx strigosa* Dalz. in Hook. Kew Journ., ii: 35 (1850); *T. tenuis* Wall. ex Dalz. and Gibs., Bomb. Fl., 61 (1861).

15. *T. subtriflora* Hochst. ex Baker in Oliver, Fl. Trop. Afr., ii: 117 (1871).

Syn: *T. pauciflora* Grahm ex Baker in Fl. Brit. Ind., ii: 114 (1876); *T. multiflora* Blatter and Hallb. in Journ. Bomb. Nat. Hist. Soc., xxvi: 239 (1918).

16. *Sesbania sesban* (L). Merill in Philip. Journ. Sc., vii: 235 (1912).
Syn: *Aeschynomene sesban* L., Sp. Pl. 714 (1753); *S. aegyptiaca* Poir, Encyc., vii: 128 (1806).

17. *Astragalus fatmensis* Hochst. ex Blatter, Fl. Arab., II, in Rec. Bot. Surv. India, 8 (2): (1921).

Syn: "*A. prolixus*" Auctt.-not of Sieber ex Bunge which is an illegitimate name and must be replaced by *A. vogelii* (Webb.) Bornm.

A. vogelii (Webb). Bornm. does not reach to the Indo-Pakistan subcontinent.

18. *Alysicarpus monilifer* (L). DC., prodr., ii: 353 (1825)
Syn: *Hedysarum moniliferum* L., Mantiss., i: 102 (1767).
Malir Cantt , subsandy soil, 8-7-58 (No. 2442); Mangopir.

19. *Trianthema portulacastrum* L., Sp. Pl., 223 (1753).
Syn: *T. monogyna* L., Mantiss., 69 (1767).

20. *Mollugo cerviana* Seringe in DC., Prodr., i: 392 (1824).
Malir, river bed, stony and sandy ground, common, very delicate minute plants which can be easily overlooked if not carefully seen, 10-10-58 (No. (2530).

21. *Gisekia pharnaceoides* L., Mantiss., ii: 562 (1771).
Malir, alluvial soil, in papaya field, common, 10-10-58 (No: 2516).

22. *Oldenlandia aspera* (Heyne) DC., Prodr., iv: 428 (1830).
Syn: *Heydotis aspera* Heyne in Roth, Nov. Pl. Sp., 94 (1821).
Malir, river bed, subsandy soil, common, 10-10-58 (No. 2547); Landhi, subsandy soil, common, very variable in size, 10-10-58 (No. 2510).

23. *Vernonia cinerea* Less. in Linnaea, iv: 291 (1829).
Mangopir, waste humus ground near cultivation, under shade, common, fls. pinkish-violet, 14-11-58 (No. 2585).

24. *Xanthium strumarium* L., Sp. Pl., 987 (1753).
Nazimabad, subsandy soil, Sept. 58 (*Ali*).

25. *Sonchus asper* (L.) Hill, Hort. Brit., i: 47 (1769).
Malir, river bed, subsandy soil, 10-10-58 (No. 2558).

26. *Aegiceras corniculatus* (L.) Blanco, Fl. Filip., i: 79 (1837).
Syn: *Rhizophora corniculata* L., Sp. Pl., 635 (1753); *A. majus* Gaertn., Fruct., i: 216, t. 46 (1788).

27. *Ehretia aspera* Roxb., Cor. Pl., i: 41, t. 55 (1795).
Malir Cantt., subsandy soil, common, 8-7-58 (No. 2441).

28. *Bacopa monnieri* (L). Pennell in Proc. Acad. Nat. Sc. Philad. 98 : 94 (1946).

Syn: All that is given under no. 82 of Jafri, Fl. Karachi in *Biologia* iv: 18 (1958).

29. *Lindenbergia indica* (L). Kuntze, Rev. Gen. Pl., 462 (1891).
Syn: *Dodarthia indica* L., Sp. Pl., 633 (1753); *L. urticaefolia* Lehm. in Link and Otto, Ind. Sem. Hort. Hamb., 1829 : 5 (1830); *L. polyantha* Royle in Benth., Scroph. Ind., 22 (1835); *L. abyssinica* Hochst in DC., Prodr., x: 377 (1846).

A very variable species.

30. *Pedalium murex* L., Syst. Nat., ed. 10: 1123 (1759).
Mangopir, loose sandy saline soil, behind the *mazar*, fls. yellow, 14-11-58 (No. 2589).

31. *Aerva persica* (Burm. f.) Merrill in Philip. Journ. Sc., xix: 348 (1921).
Syn: *Iresine persica* Burm. f., Fl. Ind., 212, t. 65 (1768); *A. tomentosa* Forsk., Fl. Aegypt-Arab., 170 (1775); *A. javanica* Juss. in Ann. Mus. Par., ii: 131 (1803).

32. *Alternanthera sessilis* (L). R. Br., Prodr., 417 (1810).
Syn: *Gomphrena sessilis* L., Sp. Pl., 225 (1753); *A. triandra* Lam., Encyc., i: 95 (1783).

33. *Euphorbia prostrata* Ait., Hort. Kew., I (ii) : 139 (1810).
Malir, sub-alluvial soil, near papaya fields, common, 10-10-58 (No. 2518).

34. *Fluggea leucopyrus* Willd., Sp. Pl., iv: 757 (1805).
Syn: *Securingaea leucopyrus* (Willd). Muell. in DC., Prodr. xv (ii): 451 (1850).

Malir Cantt., subsandy soil, common, forming scrub vegetation with other shrubs, 8-7-58 (No. 2445).

35. *Panicum turgidum* Forsk., Fl. Aegypt-Arab., 18 (1775); Ahmad and Stewart, Grasses of West Pakistan, 24 (1958).
Malir, river bed, sub-alluvial soil, common, 10-10-58 (No. 2551).

36. *Paspalidium geminatum* (Forsk). Stapf in Prain, Fl. Trop. Afr., ix: 542 (1919); Ahmad and Stewart, l. c. 39.
Mangopir, sandy saline wet soil, common behind the *mazar*, 14-11-58 (No. 2572).

37. *Cymbopogon martini* (Roxb.) Watson in Atkinson, Gaz. N. W. Prov. Ind., 392 (1882); Ahmad and Stewart, l. c. 115.
Malir Cantt., subsandy soil, common, 28-11-58 (No. 2572)

38. *Sehima ischaemoides* Forsk., Fl. Aegypt-Arab., 178 (1775); Ahmad and Stewart, l. c. 134.

39. *Hackelochloa granularis* (L.) Kuntze, Rev. Gen. Pl., 776 (1891); Ahmad and Stewart, l. c. 142.
Syn: *Cenchrus granularis* L., Mantiss., ii : 575 (1771); *Manisuris granularis* Swartz, Prodr., 25 (1788) (Linn. f. published it earlier but without description).

40. *Sporobolus tremulus* Kunth, Rev. Gram., i : 67 (1829).
Along Lyari, common in saline mud along water channel behind Bihar colony, April, 55.

Position of *Gossypium Bakeri* Watt in the Systematics of Cotton.

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&
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INTRODUCTION

We were struck by the similarity in morphological description of *Gossypium Bakeri* Watt (1926) and that of *Senra incana* Cav. (1786) which we recently collected from Thana Bulla Khan. This similarity led us to suspect that both the species were synonymous, as with such close resemblance they could not exist as two separate species. In many cases a knowledge of the chromosome number is a valuable guide in assigning a species to its proper systematic position. Cytological studies were, therefore, undertaken to determine the chromosome number, with this end in view that if *S. incana* would show the same basic chromosome number as the genus *Gossypium* it would merge with *G. Bakeri* and if it would show different basic chromosome number then *G. Bakeri* would prove synonymous with *S. incana*.

REVIEW OF LITERATURE

Watt (1926) identified a plant specimen of Hibisceae tribe sent to the Royal Botanic Gardens, Kew, by C. N. Baker from Gharo, a place in lower Sind, as a new species and named it as *Gossypium Bakeri* after C. N. Baker.

Harland (1928) questioned the validity of this species and considered it to be a variety of the four great stocks of cultivated Asiatic cottons, *arboreum*, *Nanking*, *herbaceum* and *obtusifolium*. This species was subsequently mentioned in the flora of Sind from time to time but no detailed study of this species was made. In 1947, Hutchinson, Silow and Stephens summed up the existing species of *Gossypium* but in their account also the position of *G. Bakeri* Watt remained doubtful.

In a recently published monograph, 'Flora of Karachi and Sind' by Hasanain and Rahman (1957), both *S. incana* and *G. Bakeri* are mentioned. There is no indication anywhere in the monograph whether the two species

were separately collected compared, and then incorporated in the monograph, or these names were merely compiled from the then existing flora.

MATERIALS AND METHODS

A few plants of *S. incana* were collected from Thana Bulla Khan in August, 1958, and grown in pots for further morphological and cytological studies.

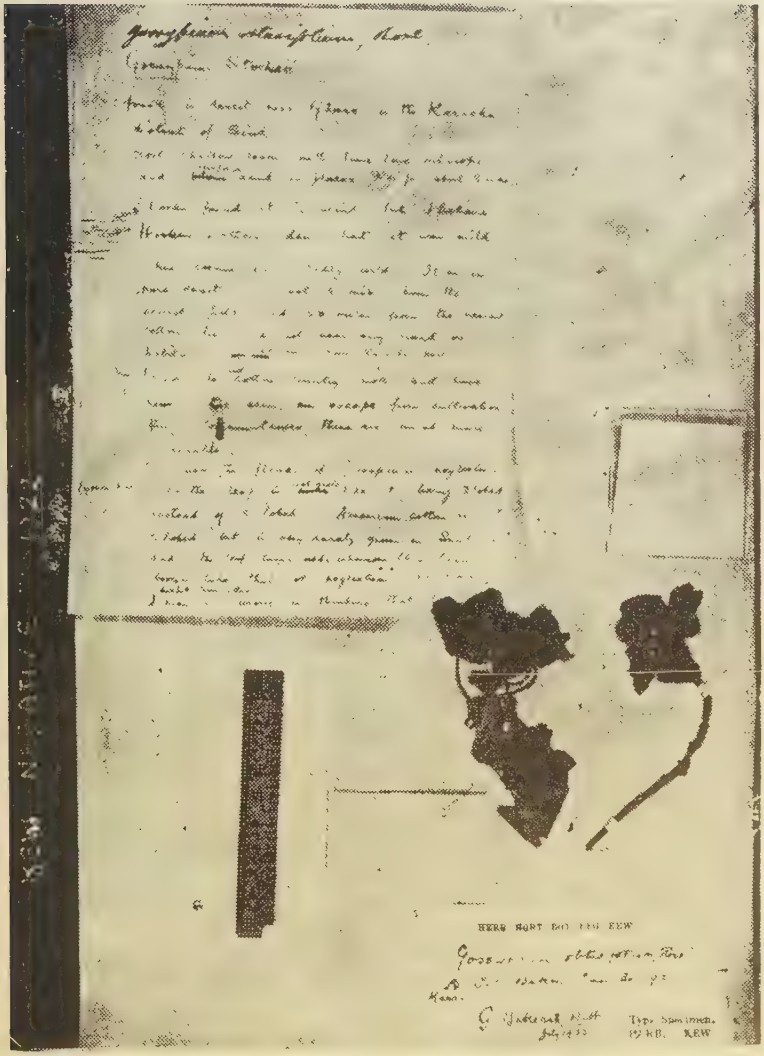
RESULTS OBTAINED

The morphological description of *G. Bakeri* and *S. incana* were carefully compared and found to be almost indentical as will be clear from Table I below :—

TABLE I

Comparative morphological characters of *G. Bakeri* and *S. incana.*

Characters	*Gossypium Bakeri*	*Senra incana*
1. Twigs, petioles and peduncles.	Densely coated with cinereous tomentum, hair matted.	Thickly covered with matted hairs.
2. Leaves.	Thick, ovate, cordate, densely tomentose, less than half cut in 3-lobes, lobes deltoid, acute, (dentate on the leaves of young foliage), veins hidden within the tomentum.	Fleshy, coated with dense hairs, three lobed, young lobes slightly dentate, veinlets entirely hidden.
3. Bracteoles.	Ovate, oblong, acute, quite entire, more than half united below, thin glabrescent, connivent, multinerved, and only very minutely cordate.	Thin, entire, acute, more than half united from below, multinerved.
4. Glands.	Not visible.	Not visible.


HERB. HORT. BOT. REG. KEW

Senra incana Cav. (1786)

5. Calyx.	Compact, short cup ending in 5 long triangular teeth, hairy on tips.	Compact, bell-shaped ending in 5 triangular teeth, hairy.
6. Corolla, fruits and seeds.	Not seen.	—

Note :—The morphological description of *G. Bakeri* has been condensed from that given by Watt (1926), while the description of *S. incana* is from the live specimen. The photograph of the type specimen of *G. Bakeri* was obtained from the Royal Botanic Gardens, Kew, and compared with *S. incana* (figs. 1 & 2). A comparison of figures 1 & 2 shows clearly that they are the photographs of the one and the same species.

The next stage in our investigations consisted in determining the somatic chromosome number of *S. incana* from the root-tips. This was found to be c.36 (fig. 3) in contrast to 26 and 52 somatic chromosome numbers reported for Old and New world cottons. This was further checked from P. M. Cs. (fig. 3) Islam & Feroza, (unpublished).

DISCUSSION

No satisfactory classification of cotton was available before Harland (1932) put forward his own on the basis of chromosome number. This classification was further improved by Beasley (1942) and Brown & Menzel (1952). Thus it is clear that the number of chromosomes is an invaluable guide in the classification of cottons in addition to the morphological characters. On the strength of the morphological similarity between the descriptions given for *S. incana* and *G. Bakeri* (Table I) the two species appear to be synonymous.

In order to see whether *S. incana* should merge with *G. Bakeri* or vice versa the chromosome number was determined. As the somatic chromosome number was found to be c.36 (Fig. 3) a number which neither the Old nor the New world cottons possess, it is concluded that *G. Bakeri* may be merged with *S. incana*. The investigations reported here further show that *G. Bakeri* cannot be an aberrant form of cultivated Asiatic cottons as suspected by Harland (1928).

From the preliminary results obtained from the crosses between *Senra* and *Gossypium* it is suggested that the two genera are inter-related.

This is not, however, unusual as similar crossing behaviour has been found between *Gossypium* and *Hibiscus* as well (Brown, 1947).

SUMMARY

Gossypium Bakeri Watt, a new species of cotton reported in 1926 by Watt, has been merged with *Senra incana* Cav. on the strength of its morphological resemblance to the latter and on the basis that it contains a different basic chromosome number

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A New Host of *Leveillula* (*Oidiopsis*) *taurica*

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Leveillula (Oidiopsis) taurica is a common parasite on a variety of plants in the Indo-Pakistan subcontinent. From the grounds of Agriculture Research Station, Tandojam the writer has found this fungus on the living leaves of *Papaver rhoeas* Linn. which constitutes a new host for it. The material, after identification, was sent to Dr J.C.F. Hopkins of the Commonwealth Mycological Institute, Kew who writes :—

> " The collection is the first one received at this Institute. We have not been able to trace any record of *Leveillula taurica* on *Papaver rhoeas*. In Golovin's paper in Acta. Inst. bot. Komarov. Acad-Sci. U.R.S.S. pl. Crypt., Ser. II, 10, p. 265. 1956, *Leveillula taurica* is given as occurring on Papaveraceae without mention of specific hosts. Your material is disposed in our herbarium as 73182 (Papaver)".

DESCRIPTION : The fungus is both endo- and ectophytic and forms white mealy growth on the undersurface of the leaves. The conidiophores are septate, hyaline, simple or more often branched and variable in length. They emerge singly or in fasicles through stomatal apertures.

The conidia are variable in shape and size. They are sub-cylindric, more or less sub-acuminate towards the apex, or irregularly shaped with middle part swollen or constricted, hyaline, single-celled with rough surface and measuring 33.4 μ to 68.5 μ x 11.7 μ to 21.7 μ. They are borne singly on the conidiophores.

Perithecial stage of the fungus was not found.

The writer has also found this fungus on the living leaves of *Centaurea moschata* and *Nicotiana sylvestris*. These, as far as the writer is aware, are new hosts for this fungus in this subcontinent.

ACKNOWLEDGMENT : I am highly indebted to Dr J.C.F. Hopkins for confirming these identifications.

Cercospora carotae (Pass.) Solheim on Carrot

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A serious leaf blight of carrot *(Daucus carota* L.) caused by a species of *Cercospora*, was noticed to occur in the vicinity of Lyallpur City. According to the available information the fungus has not so far been recorded on carrots in West Pakistan. A detailed study of the morphological characters of the fungus was made. The description of the fungus conforms closely to that of *Cercospora carotae* (Pass.) Solheim except in minor differences in the spore septation and the size of the conidiophores and conidia. The fungus is described below:-

Lesions on leaves and stems subcircular to elliptic, grey or brown to almost black, finally giving a charred appearance to the leaflets ; fruiting amphigenous, stroma lacking; *conidiophores* borne singly or in groups of two or three, rarely in fascicles of 5-10, arranged along edges of leaf, very pale olivaceous brown, usually attenuated towards the tip, sometimes with bulbous base with one abrupt geniculation, not septate, not branched, with minute spore scars, 2-4 x 10-40 μ; *conidia* cylindro-obclavate, hyaline to subhyaline, short obconic base, mostly slightly curved, septa 1-8, 8-septate very rare, septa indistinct, tip subacute to subobtuse, 2-3.5 x 20-90 μ.

Specimens deposited in the Mycological Herbarium of the Plant Pathological Section of the Agricultural College and Research Institute Lyallpur.

Septoria chrysanthemella Sacc. on *Chrysanthemum* leaves

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Dark-brown spots of irregular dimensions have been observed on the leaves of *Chrysanthemum sinense* Sabine in the flower plant nursery of the Agricultural College, Lyallpur. Lower leaves bear more diseased spots than the upper ones. When the attack is severe, the affected leaves dry up and fall, leaving the plant almost naked. Yellow flowered varieties are comparatively more susceptible to the attack of the disease than those of other colours. Affected leaves were collected and examined in the laboratory and small, round, brown coloured ostiolate fruiting bodies were clearly visible under the lens. Soaking dried portions of the leaves in tap water for a few minutes released whorls of pycniospores. Since this fungus has not been reported in this area previously, a critical study of the morphology of the fungus was made and its description is given below:-

Septoria chrysanthemella Sacc. Pycnidia numerous, maculicole, separate, pale to brown, glabrous, round to somewhat depressed equatorially, innate, average size 7 x 81.4 μ; ostiole round to oval, margin of ostiole carbonous, broken; without a rostrum or a clypeus, average size 22.7 x 29.8 μ. Pycniospores hyaline, filiform, cylindric to crescent-shaped, granular, 2-5 septate, septa distinct, tip subacute or club-shaped, pedicel acute, end cells germinating terminally, middle cells laterally, 29.6-59.2 x 1.8-3.5, mean being 47.3 x 2.8 μ.

Specimens deposited in the Mycological Herbaria of Agricultural College, Lyallpur and Government College, Lahore.

A redescription of some little known species of *Trichuris*

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College of Animal Husbandry, Lahore.

(From the London School of Hygiene & Tropical Medicine)

Trichuris spiricollis Solomon, 1932

This species was described by Solomon (1932) from *Gazella thompsoni* from Kenya. The description was based on scanty material which was not in a good state of preservation.

The following description is based on a collection, from the same host species, lying in the London School of Hygiene and Tropical Medicine. The following measurements are recorded from the material studied by the author and they are set against those of Solomon (1932) for comparison:-

measurements in millimetres)

	Solomon (1932)	Present material
Male:		
Length of anterior portion	—	26-28
Length of posterior portion	—	13.45-15 6
Length of spicule	1.0	1.1-1.48
Length of seminal vesicle	—	2.7-4
Length of ejaculatory duct	0.65	8.9-10.1
Length of cloaca	0.2-0.3	1.5-1.85
Distance from the posterior end at which spicular diverticulum - joins the cloaca		0.35-0.5
Female:		
Length of anterior portion	—	30-35
Length of posterior portion	7-9	13-15
Eggs	0.06 x 0.036	0.065-0.07 x 0.036-0.038

The anterior thin portion shows vesicles along the bacillary band.

The body width in the male is about 0.3 mm. at the commencement of the posterior thick portion and reaches a width of 0.5 mm. at about the middle of seminal vesicle. For the rest of its course the width is more or less quite uniform.

The spicule is highly characteristic, being expanded at the end like a bulb. It is 0.035-0.039 mm. thick at its proximal extremity, about 0.02 mm. in the middle and 0.013-0.014 mm. just before the distal enlargement. The enlargement measures 0.025 mm. in diameter.

The spicular sheath consists of a proximal shaft and a distal melon-shaped bulb. The proximal shaft measures 0.06 mm. in length and has a uniform width of about 0.032 mm. The melon-shaped bulb is 0.18 mm. long and is preceded by a prepuce. The spines on the proximal shaft are longer than those on the bulb and are backwardly directed.

The testis starts slightly posterior to the commencement of the cloaca and is convoluted throughout its length.

The seminal vesicle and the ejaculatory duct are joined by an inconspicuous sphincter.

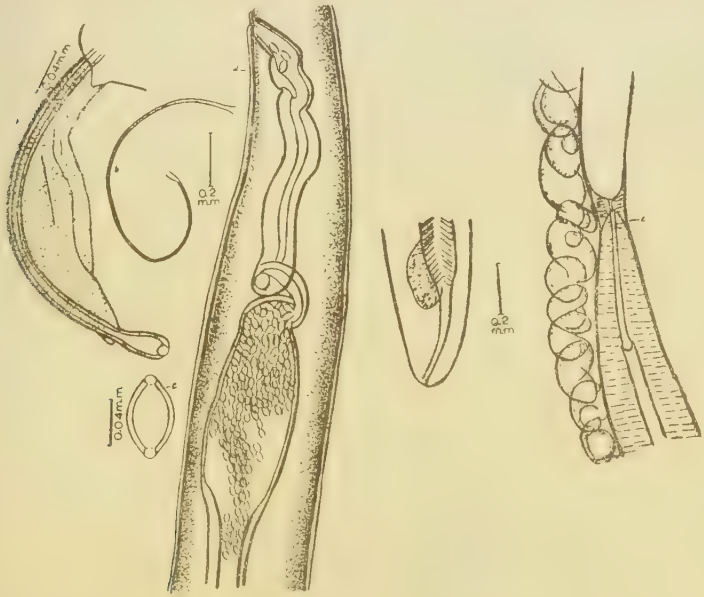

Plate I. *Trichuris spiricollis.* a. spicular sheath and a portion of spicule, b. spicule, c. egg shell, d. vagina.

The female has a maximum body width of about 0.65 mm. at the commencement of the uterus. The portion of the body accommodating the vagina is 2.6 mm. long. The anus is terminal. The vagina is characteristic, consisting of two shallow curves at its distal end, preceded by a long mid portion which after a close coil joins the broad egg reservoir. The internal lining of the distal portion is studded with spines while that of the broad proximal portion (egg reservoir) is raised into papillae.

Trichuris discolor (v. Linstow, 1906)

This species was originally described from *Bos indicus* from Ceylon, and, since then, only scattered information of a tentative nature has been forthcoming on its distribution. Taylor (1924) recorded it from a cow from Lancashire, England, and gave a short description. A collection from an ox in Lancashire, collected in 1924, and lying in the British Museum (Natural History), was found to consist of this species, while, a similar collection already identified as *T. ovis* consisted of a single male specimen of *T. ovis* and four female specimens which perfectly conformed to the description of *T. discolor*. It is highly probable that *T. discolor* is a common parasite of cattle in England. The species has also been tentatively diagnosed in cattle by veterinary practitioners in North America on a number of occasions. Lucker and Dikmans (1945) tentatively diagnosed it in the Pronghorn antelope (*Antilocapra americana*). Dikmans (1945) listed it as occurring in cattle in Alabama. But, a description of the species has not so far been published from the American material. The author examined 23 collections of *Trichuris* from cattle and buffaloes from Pakistan (Distt. Sheikhupura). All these collections were found to contain individuals which conformed to the description of this species. An unidentified collection labelled "*Bos indicus*, gut, Darjeeling, 21.5.16", deposited by Clayton Lane in the British Museum, was found to contain it. It may appear, however, that this species is quite common in Indo-Pakistan, and the records of its occurrence from England and America may suggest that its occurrence is widespread. The information from Russia is rather puzzling, Skrjabin and Sulc (1937) recognized the species and indicated its occurrence only from Ceylon. At the same time, they mentioned *T. skrjabini* to occur in cattle in Russia. What would constitute a serious omission is that whereas they had given the measurements of *T. skrjabini* from camel, goat and sheep, they had failed to state the measurements from the cattle material. The descriptions of *T. skrjabini* by Baskakov (1924),

Rassowska (1924) and Skrjabin & Sulc (1937) relate to material from sheep, goat and camel only but a description of *T. skrjabini* from cattle material is not available in the Russian literature. From the above facts it would appear that the cattle material from Russia has not been examined critically. What would further add to this suspicion is the fact that *T. skrjabini* is specifically restricted to sheep and goats and *T. discolor* to cattle and buffaloes in Indo-Pakistan.

A description of the material from Indo-Pakistan, is as follows:

MALE: The anterior thin portion and the posterior thick portion measured, respectively, 27-30 mm. and 13-15 mm. long. The body measured 0.6 mm. near the commencement of ejaculatory duct and it was found to taper posteriorly from this point to a width of 0.35 mm. This feature is highly characteristic of this species. The spicule is slender, ending posteriorly in a bluntly rounded tip, and measuring 1.5-2.02 mm. in length. The thickness of the spicule measured 0.0175-0.025 mm. at the proximal end and 0.01 mm. in the middle. The spicular sheath consists of a proximal shaft and a distal bulb. The proximal shaft measured 0.3-0.4 mm. long and 0.018-0.022 mm. broad and the distal bulb measured 0.075-0.12 mm. long and 0.03-0.07 mm. broad. The spines on the proximal shaft measured 0.006-0.0065 mm. long, and they are backwardly directed and larger than those on the bulb. The prepuce is apparently devoid of any spines. The ejaculatory duct, which is highly muscular, is joined to the seminal vesicle by a distinct short muscular sphincter. The comparative lengths of different parts of internal genitalia in four of the specimens are detailed below:

Length of seminal vesicle	Length of ejaculatory duct	Length of cloaca
2.80	9.84	1.18
2.70	13 20	1.82
3.68	14.63	0.95
3.75	9.42	1.90

The testis starts at about a distance of 1.4 mm. from the caudal end. It is straight along the posterior half of the ejaculatory duct but it is closely coiled along the proximal portion of ejaculatory duct and the entire length of the seminal vesicle. A pair of distinct conical papillae are present at the hind end.

FEMALE: The anterior thin portion and the posterior thick portion measured 22-37 mm. and 9-11 mm. long, respectively. The maximum width in the middle of the body measured 0.55-0.60 mm. The vagina

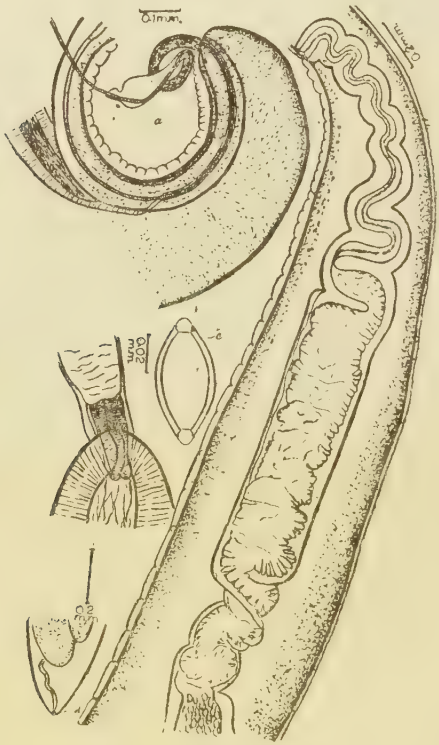

Plate II. *Trichuris discolor.* a. hind end of male, b. junction of seminal vesicle and ejaculatory duct, c. egg shell, d. posterior end of female, e. vagina.

is characteristic, consisting of a proximal and a distal portion. The distal portion consists of a pair of close curves located on either side of a more or less straight portion of uniform diameter, while the proximal portion is long and much broader. The internal lining of the proximal portion is raised into papillae, while the distal portion shows minute spines on its internl surface. The anus is terminal. The eggs measured 0.062-0.067 x 0.032-0.033 mm.

The anterior end in some of the specimens shows a dilatation of cuticle on either side at the head end but this dilatation is unlike the vesicular collar seen in such species as *T. ovis*, *T. globulosa* and *T. cervicaprae*.

Trichuris unguiculatus (Rud. 1809)

The Duke of Holstein-Beck (1785) found *Trichocephalus* in large numbers in the large intestine of hares for the first time. Rudolphi (quoted by Dujardin, 1845) found *Trichocephalus* in abundance in the hare, and in the Vienna Museum the species was recovered from *Lepus timidis* and *Lepus variabilis*. Dujardin (1845) studied the species from specimens which the Paris Museum had received from Vienna Museum through the courtesy of Prof. Valenciennes. Dujardin (1845) found that the species could be distinguished by the extremely slender spicule and sheath of the male and not the form of the head which Rudolphi had (according to Dujardin) likened to "l'ongole de l'homme".

The species has been confused with *T. leporis* throughout the literature, and Hall (1916) commented on the size of spicule as reported in *T. leporis* and suggested that there was a possibility of confusion of species.

Tiner (1950) examined the material from snow-shoe hares and cotton-tail rabbits and found that two species had been confused under the name *T. leporis* (Froehlich, 1789). He found that *T. leporis* (the species with the short spicule) occurred in North America in snow-shoe hares while the species with the long spicule and which Tiner (1950) had described under a new name *T. sylvilagi* was specifically restricted to cotton-tail rabbits *(Sylvilagus floridanus mallurus)*. Obviously, Tiner (1950) did not take into account the name *T. unguiculatus* designated by Rudolphi for the species found in hares and rabbits in Europe which was characterised by having a long and slender spicule and spicular sheath. In view of these facts the name *T. sylvilagi* is suppressed in favour of *T. unguiculatus* Rud.

The following description is based on two unidentified collections deposited by Clayton Lane in the British Museum. The collections had been labelled as originating from the caecum of hare from Berhampore (India) and dated 24.3.12. The measurements from the two collections have been tabulated in the following comparative statement :

MEASUREMENTS OF *Trichuris unguiculatus*

(Al measurements, except where indicated otherwise, are in millimetres).

	Dujardin, 1845	*"T. leporis"* of Chandler, 1930	Present Author
MALE			
Length of anterior portion	17	—	15-22
Length of posterior portion	12	15-16.5	11-13.9
Maximum body width	0.58	550 μ	0.37-0.63
Length of spicule	1.87 (+ ?)	6.7-7.8	4.09-6.11
Diameter of spicule	0.01	—	0.01
Length of spicular sheath	1.55	—	1.8
Breadth of proximal shaft of sheath	0.017	—	0.025
Length of the distal bulb of the sheath	—	—	0.13
Breadth of distal bulb of the sheath	0.0425	—	0.05
Length of cloaca	—	5.3-6.4	3.0-4.64
Length of ejaculatory duct	—	7-7.6	4.64-7.25
Length of seminal vesicle	—	3-3.5	1.8 3.24
Distance from the posterior end where spicular diverticulum joins the cloaca	—	—	1.5-1.69
FEMALE			
Length of anterior portion	23	—	14.5-24
Length of posterior portion	11.5	—	7-12.5
Maximum width at the junction of vagina and uterus	1.0	—	0.77-1.25
eggs	0.062-0.063 x 0. 031-0.034	—	0.06-0.063 x 0.03-0 032

A discrepancy in Chandler's (1930) description of *T. leporis* (*T. sylvilagi* of Tiner) in regard to the character of the spicular sheath had been partially set right by the author himself. Chandler (1930) had, at first, described the spicular sheath as "without spines, narrow and diaphanous, varying in appearance according to the degree of exsertion and contraction" and amended it later to "...pear shaped enlargement at the end of the spicular sheath, though apparently having a smooth contour, when examined with high power shows traces of very minute plaques representing rudimentary spines...". The spicular sheath in the material from India shows distinct minute spines which are somewhat larger on the shaft than on the pear shaped bu.b. The spicular sheath is long and narrow and its proximal shaft shows a uniform diameter throughout its length. The pear shaped distal swelling is followed by a prepuce which also shows very minute spines on its external surface.

There is a pair of distinct papillae at the caudal end of the male.

The testis starts at a distance of 0.68-1.24 mm. from the posterior end. It is straight in the cloacal region but closely convoluted along both the seminal vesicle and the ejaculatory duct.

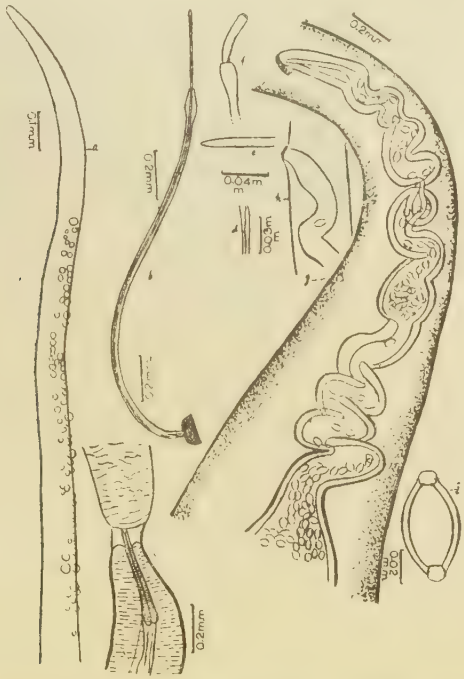

Plate III. *Trichuris unguiculatus*. a. anterior extremity, b. spicular sheath and a portion of spicule, c. junction of seminal vesicle and ejaculatory duct, d. proximal end of spicule, e. distal end of spicule, f. distal end of spicular sheath, g. vagina, h. distal portion of vagina, i. egg shell.

The vagina is slightly everted at the vulva and, after a brief straight distal portion, is thrown into a couple of coils which are preceded by a dilated portion, the egg reservoir. The egg reservoir is preceded, again, by a few convolutions before the uterus. The characteristic shape of the vagina was found to be constant in all the females in the material. As had also been pointed out by Dujardin (1845), the outermost surface of the egg shell was found to be granulated.

The anterior extremity of the worm appears rounded or truncated, depending on the state of its contraction. The bosses or plaques

start in two rows at a distance of 0.5 mm. from the anterior end and run along the bacillary band to a distance of about 2 mm. from the anterior extremity.

Trichuris tenuis Chandler, 1930.

Chandler (1930) described the species from a one-humped camel, *Camelus dromedarius*, which had died in the Houston Zoological Gardens. The species occurred in the camel in great abundance, the number of worms being estimated to lie between 20,000 and 50,000. Chandler (1930) described the species in detail but his description suffered in certain details, such as, the description of spicular sheath, which in fifty or more male specimens examined by him, was found retracted. At the same time, Chandler failed to describe or illustrate the vagina in the female.

Gebauer (1933) described *Trichuris gazelle* from *Gazella dama* which had died in the Zoological Gardens, Schönbrunn. The material on which the author based his description, consists of two male and two female specimens; and, of the two males, the spicular sheath was found partially exserted in one and fully exserted in the other. Gebauer (1933), too, did not describe or illustrate the vagina from his material.

Ezzat (1947) redescribed *T. gazelle* from the material collected by Professor Looss from a gazelle at Cairo. The precise locality and the species of the gazelle had not been mentioned by Professor Looss. This description of *T. gazelle* by Ezzat (1947) agrees in essential details with that by Gebauer (1933), the chief addition by Ezzat, however, consisting of an illustration of vagina from the Cairo material.

The author's material consisted of two collections, one comprising about two dozen specimens out of Chandler's collection of *T. tenuis* the other collected by Professor R. T. Leiper and labelled as "*Trichuris ovis*, caecum, goat, Cyprus". An examination of the two materials and the published accounts, leaves no doubt in the author's mind that *T. gazelle* is identical with *T. tenuis*.

The following description of the species *T. tenuis* is based on material studied by the author and the measurements are recored in the accompanying comparative table.

MEASUREMENTS OF *Trichuris tenuis*

(All measurements, except where otherwise indicated, are in millimetres)

	Chandler, 1930	Gebauer, 1935	Ezzat, 1947	Author
MALE.				
Length of spicule	4-5 5	3.25-4.15	3-4	4.2-4.9
Thickness of spicule	Proximal 20 μ near the tip 5μ	10 μ	9-13μ	0.025 0.012-0.015
Length of male	—	38-45	19-22	—
Length of anterior portion	16-28	—	—	20-26
Length of posterior portion	11-13	—	—	11-13.5
Maximum width	310-360 μ	480 μ	0.28-0.52	0.45-0.5
Ejaculatory duct, length	5.6-8.3	—	—	5.8-8.3
Seminal vesicle	3.2-4.5	—	—	3.6-4.3
FEMALE.				
Length, total	—	45-55	19-26	—
Length of anterior thin portion	25-35	—	—	20-27
Length of posterior thick portion	7.5-11	—	—	8-11
Max: width	300-320 μ	560 μ	0 66-0.95	0.5-0.54
Eggs: length	54-60 μ	70 μ	64-68 μ	0.06
Eggs: width	28-30 μ	32 μ	49-57 μ	0.03

MALE. The thick portion measured 0.225 mm. near its commencement, reaching a dimension of 0.45-0.5 mm. at about the middle of seminal vesicle and this width is maintained throughout the rest of the body. Gebauer (1933) described the sheath as widening distally to about double the width of its size near the root, while Ezzat (1947) described it as having "an oblong swelling which had no constant situation; in some specimens, it was found subterminal (fig. 23); in others nearly at the middle. The spines on the swelling are smaller and less than on the other part". The spicular sheath is retracted in all the specimens belonging to Chandler's material but the sheath was found semi-everted in the material from Cyprus.

There are two prominent papillae at the caudal end of the male (the cuticular "Knöpfchen" of Gebauer, 1933), measuring about 20 μ in diameter.

The testis starts a little posterior to the commencement of cloaca and is moderately convoluted along the ejaculatory duct but closely coiled along the seminal vesicle.

FEMALE. The vagina is characteristic. There is no evagination at the vulva and the vagina shows a series of convolutions in the distal

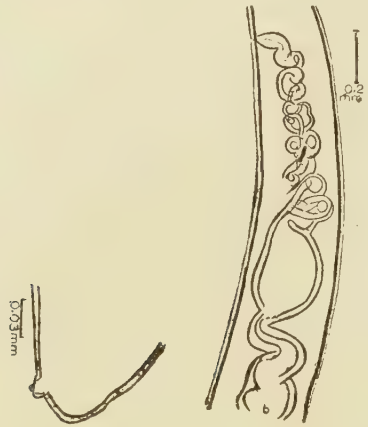

Plate IV. *T. tenuis*. a. caudal end of male *T. tenuis* (Cyprus material), b. vagina (Chandler's material), c. vagina (Cyprus material), d. hind end of female, e. junction of eminal vericle and ejaculatory duct, f. caudal end of male (Chandler's material).

portion, preceded by a pear-shaped egg-chamber or reservoir. The egg-chamber is preceded by a number of loose coils. The portion of the body accommodating the vagina measures about 2 mm. long. The body of the female gradually tapers posteriorly from the middle, ending in a conical form.

Trichuris vondwei Ortlepp, 1938

Ortlepp (1938) described this species from a cane rat *Thryonomys swinderianus* from Zululand, Natal. According to him, the cane rat was, on dissection, found to harbour five male and six female specimens of the species and only two of the females appeared to be mature and contain fully developed eggs.

Clapham (1945) described a new species under the name *Trichuris parvispicularis* from the same host as of *T. vondwei*, from a collection from Southern Rhodesia. The collection comprised 4 male and 6 female worms, of which 3 were found to be in good condition.

The author examined what is believed to be the collection on which Clapham (1945) based the description of *T. parvispicularis* and which was found lying in the London School of Hygiene and Tropical Medicine. The measurements from Ortlepp (1938), Clapham (1945) and the present

TABLE SHOWING MEASUREMENT OF *Trichuris vondwei*

(All measurements in millimetres, except where otherwise indicated)

MALE	Ortlepp, 1938	Clapham, 1945	Author
1. Total body length	—	58-72	—
2. Length of oesophageal region.	—	2/3 of the total	29-38
3. Length of posterior thickened portion of the body.	15-16	—	22-29
4. Maximum thickness of the body.	0.336-0.432	700 μ	0.85-0.9
5. Length of spicule.	1.98-2.58	2.175-2.28	2.45-2.6
6. Thickness of spicule at the proximal portion.	0.057-0.069	—	—
7. Thickness at the distal end.	0.02-0.025	25 μ	0.025
8. Thickness at the posterior end (anterior to o.1 from the distal end of the spicule).	0.03-0.035	50 μ	0.05
9. Length of cloaca.	1.8-2.27	1.17-1.87	1.85-2.2
10. Length of ejaculatory duct	6.5-8.14	—	11-13.6
11. Length of seminal vericle	4.6♀.3 (kinked condition)	—	10.2-13.3
12. Length of spicular sheath.	0.78-0.96 (measured from inside the body)	—	—
13. Length of proximal shaft of the sheath.	—	—	1
14. Size of the distal bulb of the sheath.	—	—	0.35-0.38 x 0.15-0.2
FEMALE			
15. Total length of body.	—	56-68	—
16. Length of anterior portion.	—	37-45	40-42
17. Length of posterior portion.	16-20	—	20-23
18. Maximum breath of posterior portion.	0.58-0.62	—	1.2
19. Length of vagina.	6.9-7.1	—	—
20. Eggs, Length x Breadth.	0.06-0.066 x 0.032-0.033	62-86 x 27-31 μ	0.065 x 0.0275

author are tabulated. It is clear from the table as well as from the rest of the description that *T. parvispicularis* is identical with *T. vondwei*.

It would appear from Clapham's account of *T. parvispicularis* that she was not aware of the description of *T. vondwei* by Optlepp. The differences in *T. vondwei* and *T. parvispicularis* can be fully explained on the basis of differences in the stage of maturity of the specimens.

A short description of the species is as follows :-

MALE. The distal end of the spicule conforms to the description of the species by both Clapham (1945) and Ortlepp (1938). The tip of the spicule is bluntly rounded and the spicule at about 0.1 mm. from its distal end rapidly enlarges in size. The spicular sheath comprises a proximal tubular portion and a distal melon-shaped swelling. The spines are of even density throughout the sheath but are slightly larger on the shaft than on the swelling. The proximal shaft when stretched measured 1 mm. The

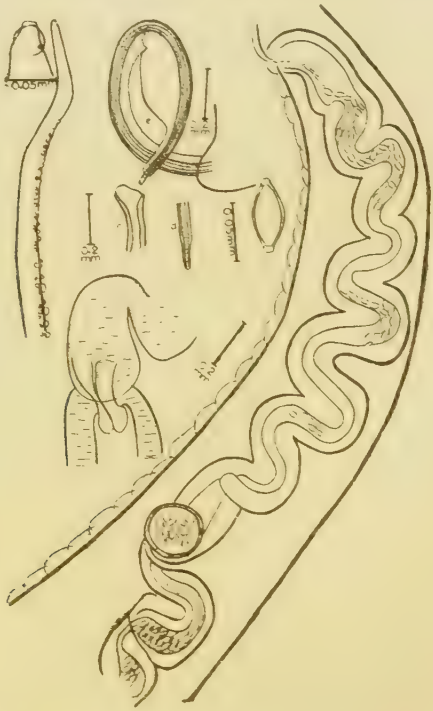

Plate V. *T. vondwei*. a. anterior extremity, b. junction of seminal vesicle and ejaculatory duct, c. anterior end of spicule, d. posterior end of spicule, e. caudal end of male, f. egg, g. vagina.

bulb of the sheath measured 0.35-0.38 mm. long and 0.15-0.2 mm. broad. The seminal vesicle and ejaculatory duct are joined by a short distinct muscular constriction. The testis is more or less straight along the ejaculatory duct and convoluted along the seminal vesicle. The opening of the cloaca is terminal in position.

FEMALE. The vagina is very long and and sinuous in its course. The anus is terminal in position and the posterior end is rounded.

The anterior extremity in both the sexes shows lateral swellings near the head end and there are two rows of vesicles along the bacillary band in the first half of the oesophageal region.

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A revision of the genus *SILENE* Linn. in West Pakistan and N. W. Himalayas

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The family *Caryophyllaceae* is divided into two well defined groups, one with free sepals, and the other with united sepals. *Silene* belongs to the second group. It can be distinguished from the rest of the genera by its calyx which has ten to an indefinite number of nerves and three styles.

Very little work has been done on the *Caryophyllaceae* of this part of the world since Hooker's time. In his Flora of British India he described nine *Silene* species from W. Pakistan and the N. W. Himalayas. In the present paper the writer has described thirteen species and besides these there are at least seven species which are either undescribed or cannot be identified here. All of these specimens are at the Gordon College herbarium.

A typical *Silene* flower has a united calyx with ten or more nerves. The petals are usually lobed with two auricles, one on each side of the petal and a pair of scales on the inner face of each petal. The claw is sometime ciliate. In a few species the petals are not lobed and the scales are absent. There are ten stamens, the filaments of the outer whorl being adnate to the petals. The ovary is three celled at the base only with an indefinite number of ovules and three styles. At the base there is a carpophore. The fruit opens by three to six valves. The seeds are reniform and usually tubercled.

I am grateful to Dr R. R. Stewart for the help he has given me in the preparation of this paper and to Mr Iqbal Sharif for drawing the figures.

SILENE Linn.

Syst. ed. 1 (1735)

KEY TO THE SPECIES

1. Calyx with 20 or more nerves; inflated in flower or fruit... ... ... 2.
   Calyx with 10 nerves ... ... 3.

2. Calyx 20 nerved, reticulately veined, inflated; flowers white; plants perennial... ... ... *S. inflata*

Calyx more than 20 nerved, inflated in fruit; flowers pink; plants annual. ... ... *S. conoides*

3. Plants annual ... ... 4.
Plants perennial ... ... 7.

4. Calyx glabrous ... ... 5.
Calyx hairy... ... ... 6.

5. Plants 3 to 5 cm. tall; calyx oval; petals slightly bilobed....*S. nana*
Plants up to 30 cm. tall; calyx clavate; petals bifid....*S. arenosa*

6. Plants 15 to 40 cm. tall; calyx campanulate; petals absent or minute ... ... *S. apetala*

7. Petals with auricles and scales... ... ... 8.
Petals without auricles, with or without scales... ... ...11.

8. Leaves linear to narrowly lanceolate... ... ...9.
Leaves lanceolate to oval or spathulate ... ...10.

9. Flowers long pedicellate, usually one terminal flower. ... ... *S. moorcraftiana*

Flowers sub-sessile, axillary and more than one terminal flower; leaves linear ... ... *S. aucheriana*

10. Basal leaves spathulate, long petioled; petals bifid, lobes entire. ... ...*S. citrina*

Basal leaves lanceolate to oval; petals bipartite, 2 auricles on each side ... ...*S. joerstadii*

11. Petals not lobed; no scales ... ... *S. falconeriana*
Petals lobed; with or without scales ... ... 12.

12. Petals laciniate; no scales; stamens long extruded. *S. griffithii*
Petals bipartite; no scales 13

13. Flowers in opposite distant cymes; calyx glabrous; styles hairy... ... ... *S. kunawurensis*

Flowers in short terminal racemes; calyx glabrous except in var. *dasyphylla;* styles not hairy... ... ... *S. tenuis*

1. Silene apetala Willd. Sp. Pl. ii (1803) 307.

S. vilis Fenzl in Ky. Pl. Pers. (1846);
S. anomala Duf. ex Rhorb. Monog. Silene 118.
S. aspera Hort. ex Rhorb. Ronog. Silene 118.
S. brachypetala Hort. ex Fenzl, Adv. Bot. (9).

S. glauca Hort. ex Rhorb. Monog. Silene 118.
S. glaucifolia Hort. ex Fenzl, Adv. Bot. (9).
S. gracilis Hort. ex Fenzl, Adv. Bot. (9).
S. lagascae Boiss. in Welw. It. Lusit. 490.
S. pallidiflora Link ex Rohrb. Monog. Silene 118.
S. praecox Hort. Par. ex Rohrb. Monog. Silene 118.
S. rigoi Boiss. Fl. Or. Suppl. (1888) 94.

Plants annual, pubescent, simple or branched, 15 to 40 cm. tall. Leaves linear to lanceolate, hairy. Flowers in one to few flowered clusters. Pedicels up to 2 cm. Calyx 5 to 7 mm. long, campanulate, nerves broad, green, prominently hairy, teeth short. Petals minute or absent. Capsule almost globose; carpophore short. Seeds 1 mm. in diameter, reniform, tubercled.

Distribution: Campbellpur, N. W. Frontier, Chitral.

2. Silene arenosa C. Koch in Linnaea 15 (1841) 712.

S. leyseroides Boiss. Diagn. Ser. I: 1 (1842) 41.
S. knowalewskyi Stschegl, Mss. in Bull. Soc. Nat. Mosc. (1853) 322.
S. salsa Boiss. Diagn. Ser. I : 8 (1849) 77.

Plants annual, slender, branched, spreading, minutely pubescent or glabrous, viscid above. Leaves linear, revolute, margin ciliate at the base. Flowers axillary and terminal. Pedicels 1 to 4 cm., thin. Calyx 1.5 to 2 cm., clavate, teeth with scarious ciliate margins, base intruded. Petals yellow brown, bilobed, lobes linear, 2 auricles at the base of the limb and 2 oblong scales. Capsule oblong, as long as the carpophore. Seeds 0.5 mm. in diameter, reniform, tubercled.

Distribution: Chitral, N. W. Frontier, Attock Dist., Hasan Abdal, Baluchistan.

3. Silene aucheriana Boiss. Diagn. Ser. I. 1 (1842) 27.

S. supina var. *latifolia* Hoh. Enum. Talysch (1853) 162.
S. hohenackeri Boiss. Diagn. Ser. II. 1 (1853) 75.
S. rudbprica Boiss. et Buhse in Nouv. Mem. Soc. Nat. Mosc. 12 (1860) 36.

Plants perennial, up to 40 cm. tall, number of branches from the base, hairy. Leaves linear, whorled, 1 to 3 cm. long. Upper part of the stem with few leaves. Flowers sub-sessile, axillary and 1 to 3 terminal flowers. Calyx clavate, hairy. Petals bipartite, 2 small auricles and 2 oblong scales, claw not ciliate. Carpophore as long as the carpel. Fruit oblong.

Distribution : Baluchistan.

4. Silene citrina Boiss. Fl. Or. Suppl. 1888.

Lychnis cabulica Aitch. Fl. Kurram, Jr. Linn. Soc. 19. non Boiss.

Plants perennial, 15 to 40 cm. tall, caespitose, tomentose, pale green. Number of erect stems from the base. Basal leaves spathulate, 5 to 15 cm. long, 1 cm. broad, gradually narrowed into a petiole. Cauline leaves shorter, sessile. Flowers 3 to 5 in a cluster, pedicels hairy, 5 mm. long. Calyx hairy, 1.6 cm. Petals bifid, 2 auricles and 2 oval scales. Capsule oval, as long as or longer than the carpophore. Seeds reniform, tubercled, 0.5 mm. in diameter.

Distribution : Baluchistan.

5. Silene conoidea Linn. Boiss. Fl. Or. 1.580; Wall. Cat. 625.

S. conica Hort. ex Fenzl, Adv. Bot. (9).
S. cylindriflora Otth, in D. C. Prod. 1.371.1824
S. dioica Fisch. & Mey. Ind Sem. Hort. Petrop.. 7 : 6.1840.
S. graeca Hort. ex Fenzl, Adv. Bot. (2).

Plants annual, up to 35 cm. tall, glandular, pubescent. Leaves lanceolate, 3 to 7 cm. long. Flowers in terminal panicles. Calyx with more than 20 nerves, glandular pubescent. Petals not lobed, pink, obovate. Capsule ovoid, tapering to a conical apex, hard, shining, enclosed in an inflated calyx.

Distribution : Plains to hills. Common weed of cultivation.

6. Silene falconeriana Benth. Royle Ill. Bot. Himal. 79.1834, (Fig. 1).

Plants perennial, up to 60 cm. tall, one or more stems from the base. Leaves linear to narrowly lanceolate, pubescent, margin ciliate to serrulate; basal leaves up to 8 cm. long, gradually smaller at the top. Flowers in opposite cymes. Pedicels slender. Calyx 1 cm long, tubular, base narrow, nerves green, teeth short, obtuse. Petals not lobed, reddish brown to yellow green. Capsule ovoid; carpophore one third the length of the capsule. Seed tubercled, one mm. in diameter.
Distribution. Swat, 5000 to 7000 feet; Tehri in forest; Mussoorie; Kangra Dist.

7. Silene griffithii Boiss. Fl. Orient, 1.637. 1884. (Fig. 2, A-B).

S. suaveolens Kar. et Kir. in Bull. Soc. Nat. Mosc. 15 (1842) 168.
S. multifida Edgew. in Trans. Linn. Soc. 20 (1846) 34.
Carpophora hoffmeisteri Kl. Bot. Reise. Pr. Wald. 139• t. 32. 1862.
Melandrium griffithi Rorhb. 1868.
S. viscosa lusus et var. *suaveolens*, Kar & Kir. Rohrb. Monog. Silene.

Fig. 1. *S. falconeriana* Benth. Habit sketch.

Fig. 2. *S. griffithii* Boiss. A, habit sketch; B, one petal.

Fig. 3. *S. inflata* smith. Habit sketch.

Plants perennial, pubescent, branched, up to 45 cm. tall. Basal leaves lanceolate to oval, about 8 cm. long, gradually narrowed into a petiole. Upper leaves sessile, lanceolate to broadly ovate. Flowers large in opposite few flowered cymes. Calyx tubular, pubescent, nerves green, teeth acute. Petals white, laciniate. Stamens long extruded. Capsule oblong.

Distribution : Swat; Chitral; Kargah valley, Gilgit; Kishenganga (Neelum) valley; Chamba.

8. Silene inflata Smith, Wall. Cat. 623; Boiss. Fl. Or. 1.628. (Fig. 3).

Cucubalus behen Linn.
S. wallichiana Kl. in Bot. Reis. Pr. Waldem 139, t 30. 1862.
S. cucubalus Wib. in Rohrb. Monog. Silene 84. 1868.

A tall plant, perennial, branched, glabrous. Leaves 2 to 7 cm. long, oval to ovate. Flowers long pedicellate. Calyx ovoid, base intruded, nerves 20, reticulately veined. Petals white, bilobed. Capsule globose. Carpophore short.

Distribution : Chitral; Swat; Gilgit; Hazara Dist., Kaghan Valley; Murree Hills; Chamba; Lahoul; Kashmir.

9. Silene joerstadii Wendelbo, Nytt. Mag. for Bot. 1:1952. (Fig. 4, A-B)

Plants perennial, up to 30 cm. tall, pubescent. Basal leaves lanceolate to oval, 10 cm. long and 1 cm broad; upper leaves oval to ovate, about 3 cm. long. Flowers 3 to 5 in terminal clusters; pedicel 7 mm. long. Petals greenish white, bifid with 2 auricles on each side and 2 oblong scales. 3 hairy styles. Fruit oblong, surface smooth and shining, opening by 6 valves. Seeds reniform, echinate.

Distribution : Chitral.

10. Silene kunawurensis Benth. in Royle Ill. 79. 1834.

Plants perennial with number of branches from the base, up to 45 cm. tall. Basal leaves lanceolate to spathulate, about 4 cm. long; upper gradually smaller, linear. Flowers in opposite pairs of distant cymes; pedicels slender. Calyx tubular, glabrous, teeth scarious. Petals greenish yellow, bipartite, 2 small linear scales, no auricles, claw hairy. Fruit ovoid, longer than the carpophore. Seeds slightly reniform, not tubercled, 0.5 mm. in diameter.

Distribution : Swat; Kunawar.

11. Silene moorcraftiana Wall. Cat. 626; Rohrb. Monog. Silene 129 (Fig. 5).

Plants perennial, pubescent, branched from the base. Basal leaves linear, up to 3 cm. long, gradually narrowed towards the base. Upper leaves shorter. Stem erect, up to 30 cm. tall, slender. Usually 1 terminal flower; pedicel 1 to 6 cm. long. Calyx clavate, hairy, 2-2.5 cm. long, teeth obtuse. Corolla 3 cm. long; petals reddish white, bilobed, auricled. 2 oblong scales. Fruit oval to oblong, as long as the carpophore.

Fig. 4. *S. joerstadii* Wendelbo, A, habit sketch; B, one petal.

Fig. 5. *S. moorcraftiana* Wall. Habit sketch.

Distribution : Baltistan, Hushe valley; Above Ushu, Swat; Chitral; Naltar Valley and Ishkoman Pass, Gilgit. Rattu, near Astor; Ladak; Lahoul; Sonamarg.

Fig. 6. *S. nana* Kar. & Kir. A, habit sketch; B, one petal.

12. Silene nana Kar. et Kir. Enum. Pl. Song. 1841. (Fig. 6, A-B)

Plants annual, 3 to 5 cm. tall. Stem with short internodes and few branches. Leaves crowded, lanceolate, scabrous, ciliate margins. Flowers axillary or terminal with pedicels almost as long as or longer than the flowers. Calyx tubular, glabrous, teeth acute with ciliate margins. Petals white, slightly bilobed, 2 scales. Capsule oval. Seeds almost round with a notch on one side, 1.5 mm. in diameter.

Distribution : Baluchistan.

13. Silene tenuis Willd., Rhorb. Monog. Silene 186. (Fig. 7, A-B)

S. amoena L. Sp. Pl. 417

S. chamarensis Turcz. in Bull. Soc. Nat. Mosc. 15 (1842) 578.

S. ambigua Turcz. in Bull. Soc. Nat. Mosc. 15 (1(842).

S. baicalensis Turcz. in Bull. Soc. Nat. Mosc. 15 1842) 575.

S. bupleuroides Schang. ex Bunge, Verz. Alt. 31.

S. graminifolia Otth. in D. C. Prod. 1:368. 1824.

S. guilelmi-waldermari, Cl. in Bot. Ergeb. Waldem. Reise. 140. 1862.

S. jenisea, Poir. Encyc. Suppl. 5:154.

S. repens, Boiss. Fl. Or. 1:614. 1884.

S. sajanensis, Less. ex Ledeb. Fl. Ross. 1 : 307. 1844.

S. stenophylla, Ledeb. Fl Rcss. 1 : 306. 1844.

S. tenuifolia Otth. in D. C. Prod. 1 : 379. 1824.

S. turgida, Schrenk, ex Rohrb. Monog. Silene, 187.

S. viscaginoides, Hornem. Suppl. Hort. Hafn. 49.

Plants perennial, 10 to 50 cm. tall; older plants shrubby with number of stems from the base. Leaves mostly radical, 3 to 10 cm. long, linear, ciliate margins. Flowers in short terminal racemes. Bracts 1 cm. long, subulate, ciliate margin. Pedicels short, less than 1 cm. in

length. Calyx glabrous, membranous in fruit and when dry campanulate, teeth obtuse, margin ciliate. Petals yellowish to brown, bipartite,

Fig. 7. *S. tenuis* Willd. A, habit sketch; B, one petal

2 oval scales. Capsule oblong; carpophore short. Seed 0.7 mm. in diameter.

Distribution : Baltistan; Deosai plains; Chitral; Poonch; Gilgit agency; Kaghan Valley; Sonamarg; Upper Lidder valley; Zogibal Pass.

S. tenuis var. dasyphylla Turcz. is pubescent. Lahoul.

S. tenuis Willd. is included in section Auricularia in Hooker's Flora of British India but the petals do not have any auricles. It should have been placed in section Otites.

In addition to the species already mentioned there are no less than 7 species which I have not been able to identify and which may be undescribed. I am giving their numbers and a short description of each.

Near Quetta, *Stewart* 28134.	Annual; about 15 cm. tall; axillary and terminal rose coloured flowers. Leaves linear.
Drosh, Chitral, *Stainton* 2362.	Perennial, 25 cm. tall; more than one branch from the base; minutely pubescent. Leaves linear, 4 cm. long. Flowers terminnal, 2 cm long; petals bipartite, 2 lanceolate scales, claw ciliate; styles long and hairy at the base.
Turikho river, Chitral *Stainton* 2505.	Perennial, 20 cm. tall, more than 1 branch at the base; minutely pubescent. Flowers axillary and terminal, subsessile. Calyx 2.5 cm. long, hairy. Petals dark purple, bilobed, two wedge shaped scales with upper margin wavy.
Jutial Nala, Gilgit, *Stewart* 26266.	Perennial, 30 cm. tall; a number of branches from the base; stems slender, minutely pubescent. Leaves lanceolate, 1 to 1.5 cm. long, apex acute. Flowers mostly terminal. Sepals up to 2 cm. long. Petals bipartite, each lobe bifid, two auricles and two scales. Carpophore twice as long as the ovary.
Rattu, near Astor, *Stewart* 22790.	Perennial, 50 cm. tall. Leaves lanceolate, 4 to 7 cm. long. Flowers in opposite pairs of cymes. Calyx 1.5 cm. glabrous. Petals bilobed.
Naltar Vy. 10003-11000', *Stewart*	Perennial, 40 cm. tall. Leaves linear to lanceolate. Flowers in pairs; pedicels long. Calyx 2 cm. long, glabrous. Petals bipartite, two small scales. Styles ciliate.

Pezu, *A. R. Beg* 25865.

Plants annual; number of branches from the base, hairy. Leaves linear to lanceolate, 1 cm. long, hairy. Flowers short pedicelled. Calyx 1 cm. long, clavate. Petals united, each petal bilobed with two oblong scales.

Vaginal Smears in the Northern Palm Squirrel

(*Funambulus pennanti* Wroughton)

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INTRODUCTION

During the various phases of the oestrous cycle in most mammalian species, some changes occur regularly in the ovary and the genital tract. These changes in the reproductive system are dependent on cyclic production of gonadotrophic and gonadal hormones. In some mammals the amount of these hormones in the blood stream does not fluctuate much, with the result that the aforesaid changes are not very conspicuous and regular, while in others the hormonal level fluctuates greatly and produces well-defined cyclic changes in the reproductive organs as well as in the behaviour of the animal.

Of all parts of the reproductive organs the vagina permits a study of its cyclic changes most easily. It is well-known that during the oestrous cycle the number and nature of cells in the vaginal fluid also vary in a regular manner and they can be studied very satisfactorily in smears. Such a cyclic activity of the (epithelium of the) vagina has been reported in a very large number of mammals including *Citellus* (Coco, 1942; Johnson, Foster & Coco, 1933; Foster, 1934) and *Sciurus* (Deansely & Parkes, 1933).

These studies show that a classification of the various stages of the oestrous cycle can conveniently be based on the vaginal smears. The present studies aim at working out such a classification in the northern palm squirrel, *Funambulus pennanti*, so that it may become possible to determine the condition of the reproductive system merely by looking at the vaginal smears. In order to find out the hormones responsible for producing a particular stage in the vaginal cycle some experimental work involving the administration of gonadal hormones has also been undertaken.

MATERIAL AND METHOD

The present paper is based on a study of more than three dozen adult and immature specimens of the northern palm squirrel, *Funambulus pennanti* Wroughton, captured in the vicinity of Lahore and kept in the laboratory in small wooden cages. Vaginal smears were taken at least once every day. During the early stages of the oestrous cycle, however, smears were taken in the morning as well as in the evening.

The vaginal smears were taken by means of a fine glass rod with a rounded tip. This type of rod is easily made by pulling out a glass rod (about 3 mm. in diameter) to a thread-like fineness and heating the tapering end gently to form a rounded bulb at the tip. Bulbs of 1 mm. diameter proved to be most suitable for the purpose.

When taking smears the end of the rod was moistened with physiologic saline solution and inserted into the vagina. The rod was gently rotated in order to collect the fluid from the lumen. It was then taken out and the vaginal contents adhering to it spread on a coverslip previously besmeared with Meyer's albumen. The film thus formed was partially air-dried. In the beginning the conventional fixative consisting of equal parts of ether and 95% alcohol was used. It was, however, found that the cells fixed in this way lost their original shape after some time. This fixative was soon given up in favour of Bouin's fluid. The technique of fixing vaginal smears on coverslips is as follows: the coverslip with the smeared surface facing downwards is gently dropped into a watch glass containing Bouin's fluid in such a way that it remains floating on the surface. After being left undisturbed for one minute, the coverslip is turned upside down with forceps and passed through the usual grades of alcohol. This procedure which has been evolved by protozoologists ensures even and quick fixation.

In the beginning both the fixatives were used side by side in order to effect proper comparison and guard against any artifacts which might be produced by the new technique of fixation. It was found that the smears fixed with Bouin's fluid were in no way inferior to those fixed with alcohol-cum-ether. On the contrary the cells fixed in the former did not lose their shape even after one year.

Acid Haemalum was found to be the most convenient nuclear stain. Heidenhain's Iron Haematoxylin also gave excellent results. Eosin and Fast Green were used for counterstaining.

The hormones used were Estrabenzon (=Estradiol benzoate in oil) and Corpuluton (=progesterone in oil), both manufactured by Scanpharm. The hormones were injected subcutaneously.

OBSERVATIONS

Cell Types

The main cell types in the vaginal smears of the northern palm squirrel are as follows:

TYPE 1. These are the largest cells in the vaginal smear and are of the squamous epithelial type. They are extremely thin and scale-like. They are but little cornified, their edges being wavy but never folded (fig. 1). The nucleus is situated in the centre of the cell. It is spherical or ovoid in shape with one or more nucleoli. The nucleoli may not, however, be well defined in some cases. The nucleus takes a brilliant blue stain with Haemalum. Some of the larger epithelial cells are binucleate. The epithelial cells fall into two categories depending on their affinity with Eosin. The cytoplasm of some epithelial cells stains light pink with Eosin and their cell membrane is not wrinkled even very slightly *(*fig. 1, *E. C. 1)*. Other epithelial cells, however, have a greater affinity for Eosin and their cell membrane shows some plasmolysis (fig. 2, *E. C.* 2). Nevertheless, this type of cells cannot be put in the category of truly cornified cells.

The smears of epithelial cells look very interesting when treated with Fast Green. The mucilaginous film forms a deeply stained background while the epithelial cells are represented by clear, almost unstained areas.

The size of the cell varies from 27 to 51 microns, and that of the nucleus from 7.5 to 10 microns.

TYPE 2. These cells may show various degrees of cornification (fig. 2). The shape of these cells is irregular and their margins folded. The margins may be folded to such an extent that the cell assumes the shape of a cylinder. Because of cornification the cytoplasm shows irregular striations and stains deeply but unevenly with Eosin.

The cells of this type exhibit various stages in the process of cornification right from the slightly cornified cells with a more or less vesicular nucleus to highly cornified cells with a deeply staining compact nucleus. Nevertheless for the sake of convenience two main categories of such

cells may be recognized: (a) cornified cells which are not very angular and in which the nuclei are somewhat vesicular (fig. 2, *C. C. 1*). The size of such cells varies from 25 microns to 50 microns; and (b) cornified cells which are angular and narrow and in which the nuclei are quite compact. The size of these cells varies from 30 to 50 microns in length while they may be as narrow as 8 microns in breadth (fig. 2, *C. C. 2*).

TYPE 3. These cells are characterized by the possession of a smooth and well defined cell boundary. They show no plasmolysis and possess a normal healthy structure. They can be classified into two groups. One group comprises small round cells which possess a very large nucleus in a relatively thin envelope of cytoplasm (fig. 3, *R. C.*) The nucleus in this case may be eccentric or central in position. The cytoplasm stains deeply with Eosin. The size of these cells varies from 12 to 15 microns while the size of the nucleus is usually 8 microns. The second group includes cells which possess a more or less oval outline (fig. 3, *O. C.*) and a broad rim of cytoplasm around the nucleus. The cytoplasm does not stain so deeply with Eosin as in the cells of the first group. These cells measure about 23 microns along their long axis. The size of the nucleus is about 10 microns.

TYPE 4. These comprise the leucocytes. At least two types of leucocytes are met with——the polymorphs (figs. 3 & 4, *P.*) and the monocytes (fig. 4, *M*). The polymorphs are much more numerous than monocytes. The nuclei of the polymorphs present the various characteristic shapes. The monocytes are round cells with a horse-shoe-shaped nucleus lying eccentrically.

Stages of the Oestrous Cycle

Although the so-called stages of the oestrous cycle merge with each other and their delimitation is arbitrary, yet, for the sake of convenience and clarity, it is advisable to divide the cycle into stages. In the northern palm squirrel, at least four stages of the oestrous cycle can be distinguished.

Stage 1. PROOESTRUM. With the approach of prooestrum, the epithelial cells (type 1) make their appearance in the vaginal smears in very large numbers (table I). At this stage the consistency of the vaginal fluid is mucus-like, and it is produced in such large quantities that it frequently oozes out and sticks to the labia forming tiny solid masses on drying. At this time cells of no other type are present (fig. 1). This is in

TABLE I

Percentage of various types of cells in the vaginal smears of a normal female

Date	Type 1	Type 2	Type 3	Type 4
March 1	100.0	—	—	—
2	21.5	78.5	—	—
3	6.0	28.0	64.0	2.0
4	4.0	36.0	48.0	12.0
5	4.0	28.0	52.0	16.0
6	3.0	27.0	51.0	19.0
7	1.5	4.5	4.0	91.0

contrast to the condition found in the guinea pig where cornified cells may also be present from the very beginning (Young, 1937). At the close of the prooestrum, i.e., late on the second day, however, a few cornified cells do make their appearance.

Stage 2. OESTRUM. By the third day, the number of epithelial cells is considerably on the decrease while the number of cornified cells begins to increase (fig. 2; table I). That stage of oestrus in which the cornified cells are more numerous than the epithelial cells, lasts for about one day. The leucocytes also make their appearance and are present in moderate numbers (table I). In some cases they are seen to lie in close contact with the epithelial cells.

During oestrum all the transitional stages from the little cornified epithelial cells to highly plasmolysed and cornified cells can be seen (fig. 2, *E. C.*). Some of the cornified cells are relatively small (fig. 2, *C. C.*). The small size and the structure of these cells suggest that they have been derived not from the large epithelial cells but from smaller ovoid cells.

Stage 3. METOESTRUM. On the fourth day of heat, type 3 cells appear in the vaginal smear in large numbers, though in the beginning there is no significant decrease in the number of cornified cells. Late in metoestrus a large number of rounded cells make their appearance, while the cornified cells show numerical reduction (table I).

There are various stages in the process of degeneration of epithelial cells. In some cases only the nuclei of these cells remain while the entire cytoplasm disintegrates. Such nuclei can be stained pink with Eosin, but are not affected by basic stains. The smear at this tsage is scanty. Next, there is a sudden influx of a large number of

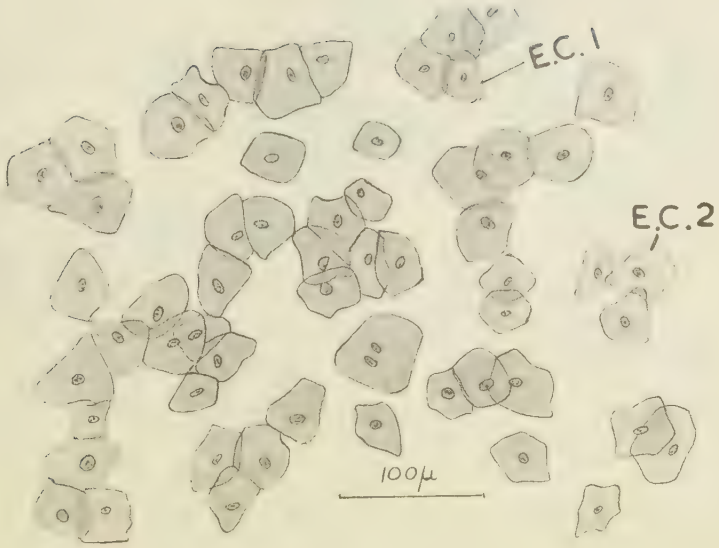

Fig. 1. Vaginal smear of the prooestrous stage. *E. C.* 1., epithelial cells showing no plasmolysis; *E. C.* 2., epithelial cells showing a slight degree of plasmolysis.

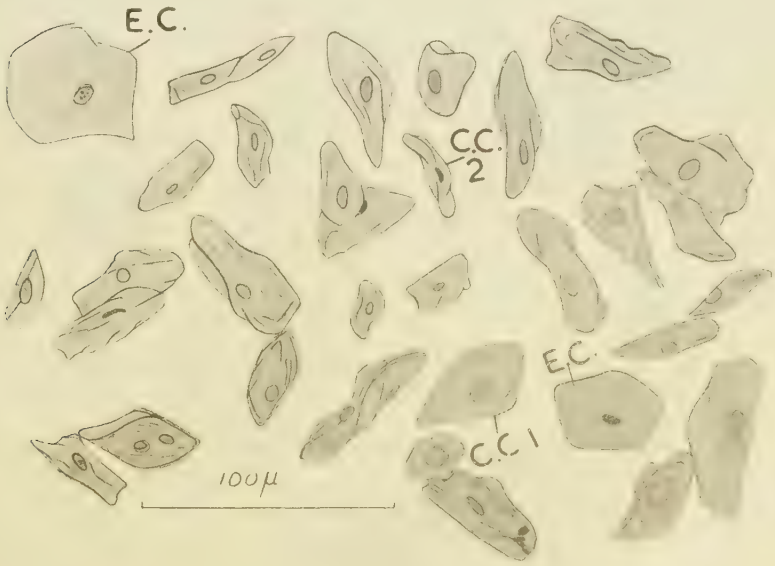

Fig. 2. Vaginal smear of the oestrous stage. *C. C.* 1., moderately cornified cells; *C. C.* 2., highly cornified cells; *E. C.*, epithelial cells.

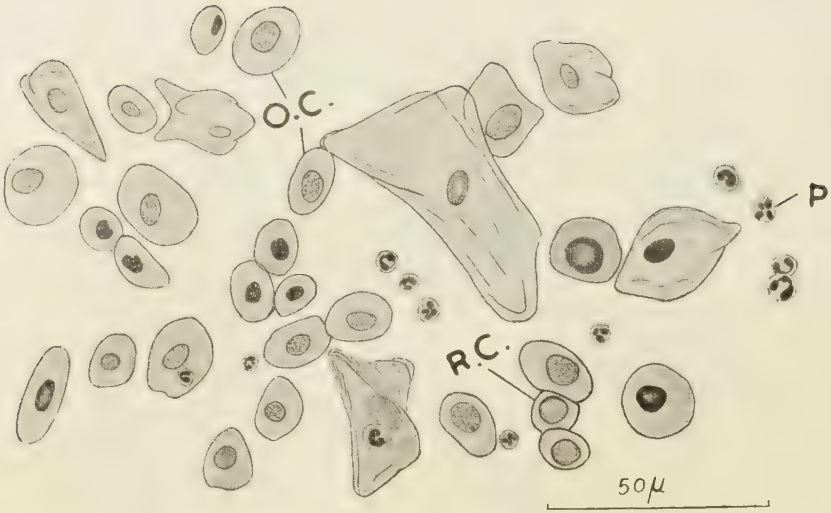

Fig. 3. Vaginal smear of metoestrous stage. *O.C.* oval cell; *P.* polymorph leucocyte; *R. C.*, round cell.

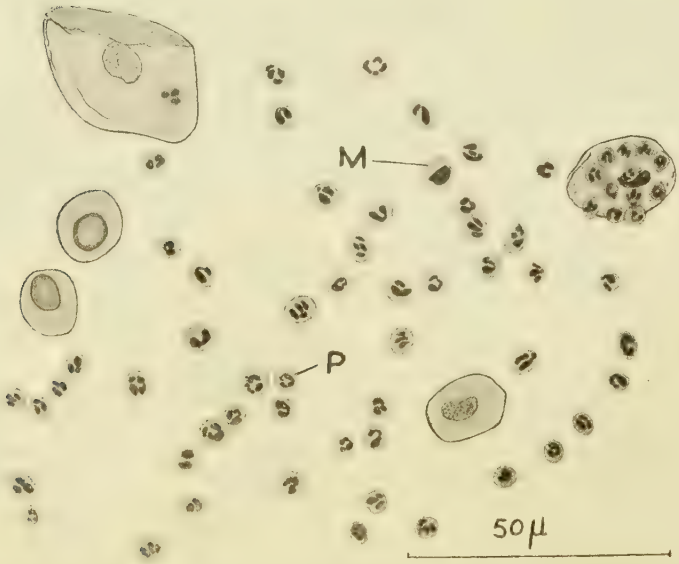

Fig. 4. Vaginal smear of postoestrous stage. *M.* monocyte: *P.* polymorph leucocyte.

leucocytes marking the beginning of the postoestrum. Metoestrum lasts for about four days.

Stage 4. POSTOESTRUM. The number of leucocytes increases greatly. Groups of leucocytes surround the cells and in many cases enter their body. It is held that they absorb the cell wall and the nucleus by a process akin to phagocytosis. In a smear of this stage clusters of leucocytes are seen surrounded by the remains of the cells, in which the nucleus has been completely digested. The end of the oestrous cycle is characterized by a reduction in the number of cells of all types in the vaginal smear. Cell debris is, however, present.

It is clear from table I that the appearance of various types of cells in the smear is very abrupt but their decline in number is gradual. The rate of decrease in percentage of different types of cells, however, is not very regular and the percentage of some cell types may actually increase to a slight extent during some periods.

RELATION BETWEEN THE OVARY AND THE CELLS IN THE VAGINAL SMEAR

By studying the structure of the ovaries fixed at various stages of the oestrous cycle, striking correspondence is seen to exist between the ovarian and the vaginal cycles. During prooestrum there is a considerable increase in the rate of development of follicles in the ovary. Coincident with this increase of follicular developement is the appearance of type 1 cells. As soon as the second stage of the vaginal cycle approaches, sections of the ovary show that follicles intermediate in size at the early stage of the cycle have become greatly enlarged. Although by the middle of oestrous cycle the follicles may attain a size of 450 microns, yet the actual number of follicles decreases as compared with the prooestrous condition. Ovaries taken out at a time when round cells and leucocytes are abundant in smear, showed corpora haemorrhagica. This means that, most probably, ovulation takes place at the end of the oestrous or at the early metoestrous stage. Ovaries fixed during prooestrous and early oestrous showed no indication of ovulation.

In late metoestrus and postoestrus, when the leucocytes are abundant in the smears, the formation of corpora lutea is in progress and the development of new follicles is slowed down greatly though not arrested completely. Also at this stage the ovarian stroma records an increase, perhaps partly due to the development of connective tissue in place of the large follicles which had become atretic earlier.

EFFECT OF OESTRADIOL AND PROGESTERONE ON THE DISTRIBUTION OF VARIOUS TYPES OF CELLS IN THE VAGINAL SMEARS

In an attempt to determine the specific role played by oestradiol and progesterone in the activation of the vaginal epthelium, the effect of these hormones was observed on the distribution of various cell types in the vaginal smear. In the following account type 1 and type 2 cells are considered together under category A and type 3 cells are considered under category B. This arrangement has been adopted in view of the fact that, as described above, cells of category A are characteristic of prooestrous and oestrous stages while the cells of category B are abundant during the late stages of the cycle. A relatively large dosage of hormone was selected in order to minimize the internal hormonal factors.

(i) EFFECT OF OESTRADIOL: Three immature females were injected with oestradiol benzoate. In all 8 mgs. were given to each female spread over ten days in doses of 1 mg. Evidences of cornification appeared two days after the first injection was given. Vaginal smears were taken on alternate days. Table II shows the mean percentage of various types of cells present in the vaginal smears of all the three animals.

TABLE II

Day after the first injection	Percentage of cells		
	Category A	Category B	Leucocytes
3 rd	92.0	8.0	—
5 th	96.0	4.0	—
7 th	98.0	2.0	—
9 th	98.5	1.5	--
11 th	98.0	2.0	—

Majority of the cells of category A present were large squamous epithelial cells with only slightly plasmolysed cell walls. True cornified cells were relatively few.

(ii) EFFECT OF PROGESTERONE: Another set of four immature animals was administered an identical dosage of progesterone for the same period. In none of these animals did the evidences of cornification or mucification in the vagina appear.

(iii) EFFECT OF OESTRADIOL PLUS PROGESTERONE: In an attempt to induce the oestrous cycle in immature females, the effect of progesterone given in addition to oestradiol was observed on three squirrels. The results obtained are given in a tabular form below.

TABLE III

Day	Amount of hormone administered	Mean percentage of cells in smears of experimental animals		
		Category A	Category B	Leucocytes
1st	0.5 mg Oestradiol benzoate	—	—	—
2nd	0.5 mg Oestradiol benzoate	—	—	—
3rd	—	100.0	—	—
4th	—	100.0	—	—
5th	0.5 mg Progesterone	99.5	0.5	—
6th	0.5 mg Progesterone	4.0	18.5	77.5

In all experiments controls of the same age group were run. In the majority of controls the vulvar opening remained so small that proper penetration of the glass rod could not be effected and hence smears could not be taken. In a few cases where smears were taken the contents were scanty and comprised mainly the debris characteristic of the dioestrum.

DISCUSSION

The effect of gonadal hormones on the distribution of various cell types in the vaginal smears indicates that maintenance of a high level of oestrogen is responsible for the changes that occur during prooestrous and early oestrous stages of the normal cycle. Progesterone, even when given in large doses, seems incapable of bringing about any change in the vaginal epithelium. However, if progesterone is given after the vagina has been sensitized by oestrogen, there is a sudden appearance of round and oval cells and leucocytes, and a marked decrease in the percentage of squamous epithelial cells (table III). This is characteristic of the late stages of the oestrous cycle.

The striking fact in this case is the inefficacy of progesterone

in the absence of sufficient quantities of oestrogen. Similar results have been obtained by Allen & Meyer (1933) in the case of mice.

Theoretically progesterone can act in two ways to bring about metoestrous and postoestrous changes in the vagina, viz., either by exerting a sudden check on the supply of oestrogen without having a direct and specific effect on the vaginal epithelium, or by acting directly on the vaginal epithelium in cooperation with oestrogen. In the latter case the role played by oestrogen may be of a biocatalyst, or it may be that oestrogen simply brings about certain changes in the vagina which are a prerequisite for the subsequent action of progesterone. One of the well know effects of oestrogen on the vaginal lining is its stratification (Burrows, 1949). It is also held that stratification is not necessarily accompanied by cornification. The vaginal epithelium, just before the onset of heat, is stratified but not cornified (Freud, 1938; Burrows, 1949). It is probable, therefore, that during prooestrus the secretion of oestrogen is capable of producing stratification of the vaginal epithelium but as the level of oestrogen increases there is also a cornification of the superficial layers. It may also be conjectured that as soon as the corpora lutea begin to secrete progestin there is a sudden fall in the production of oestrogen so that no more cornification occurs, though oestrogen is still present in sufficient quantities to maintain stratification of the vaginal epithelium. It may be assumed that at this stage the cells take up a rounded or oval shape and are filled with mucus under the influence of progesterone. Burrows (1949), however, is of the opinion that stratification is not very essential for mucification "for it is absent during lactation, although the vaginal epithelium is of the mucus-producing type at that period." At this stage there is also an invasion of leucocytes which is generally attributed to a variation of pH or due to a sudden change of electric potential in the vagina duing the heat period (Burrows, 1949).

When considering the action of sex hormones in a particular animal, one should take into consideration the fact that the nature of reactivity of one type of tissue differs in various groups of animals. In the cow, for example, progesterone plays an important and direct role in increasing the percentage of cornified cells in the smear (Hansel et al, 1949), but this is not the case in rodents. It is obvious, therefore, that an exact knowledge of the sex hormones in relation to the changes which the reproductive tract normally undergoes is very essential before hormonal therapy can be employed successfully in initiating an oestrus approaching very near to the norm so that fertile matings can be obtained.

SUMMARY

1. The normal vaginal cycle in *Funambulus pennanti*, as determined by vaginal smear technique, has been described.

2. The effect of Oestradiol benzoate and progesterone has been noted on the distribution of various cell types in the vaginal smear.

3. The possible role of gonadal hormones on the vaginal epithelium has been discussed.

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The fate of a braconid parasite, Rogas testaceus, in four species of hosts

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It has been shown in a recent paper that when the ichneumonid parasite *Nemeritis canescens* is injected into hosts to which it is alien, it often evokes defence reactions which cause its death (Salt, 1957). The defence reactions observed in a wide variety of insects took two forms: a haemocytic reaction leading to the formation of an envelope surrounding and isolating the parasite; and a melanin reaction leading to the deposition of melanin on the surface of the parasite or inside its pharynx and anus.

It is clearly desirable to learn whether similar reactions are evoked by parasites other than *Nemeritis*; and during a recent visit to Pakistan I took the opportunity of studying *Rogas testaceus* Spinola, an endophagous parasitoid belonging to a different family, the Braconidae. Eggs and young larvae of that species were injected into caterpillars of its natural host, *Earias*, of two other cotton pests, *Platyedra* and *Sylepta*, and of the flour-moth, *Ephestia*; and the fate of the young parasites was observed by dissecting the hosts after the lapse of different intervals of time. The purpose of this paper is to record the reactions of those hosts to *Rogas*, and to compare them with the known reactions to *Nemeritis*.

MATERIAL AND METHODS

The biology of *Rogas testaceus* has been described in an admirable paper by Muzaffer Ahmad (1943) and only an outline need be given here. The adult female attacks the young larva of spotted bollworms of cotton, *Earias insulana* and *E. fabia*, and by means of a protrusible ovipositor inserts an egg into the body cavity. The egg hatches to a larva which feeds on the haemolymph of the host, avoiding the vital organs. After about 15 days, at autumn temperatures, the parasite larva enters its fifth instar and begins to feed voraciously on the remaining contents of its host, which is by this time a third- or fourth-instar caterpillar. The full-grown parasite larva pupates inside the empty skin of the host, which becomes hard and brown, like a puparium. About three weeks later the adult parasite is mature. It bites its way

through the hardened skin of the host and emerges to repeat the life cycle.

In order to obtain eggs of *Rogas* for experiment, female parasites were put into vials with cotton bolls containing young larvae of *Earias insulana*. After two days, the small bollworms were dissected in insect saline and the parasite eggs were pushed to one side of the watch-glass ready for injection. It was found possible to use not only eggs but also young larvae of *Rogas*. In some cases, small bollworms collected in the field were dissected and parasite eggs or recently hatched larvae found in them were used for experiment; but whenever a host was found to contain two or more larvae of *Rogas* those parasites were not used, because there was danger that the larvae might have affected each other, and one or both might not be viable.

Some of the caterpillars of *Earias* used as hosts were reared from eggs in the laboratory; but fifth-instar caterpillars collected in the field could also be used safely, because they had passed the period at which they could already contain a *Rogas*. The larvae of *Platyedra* injected were all obtained from cotton bolls collected in the field. They were larvae in the last instar and in a state of dormancy. The caterpillars of *Sylepta* used for experiment were from field collections of small larvae. They were fed on cotton leaves in the laboratory for a week or more before use and were known, from other work, to be free of parasites. The *Ephestia* came from a culture maintained at the Zoological Laboratory, Cambridge, and were fed on whole-meal flour.

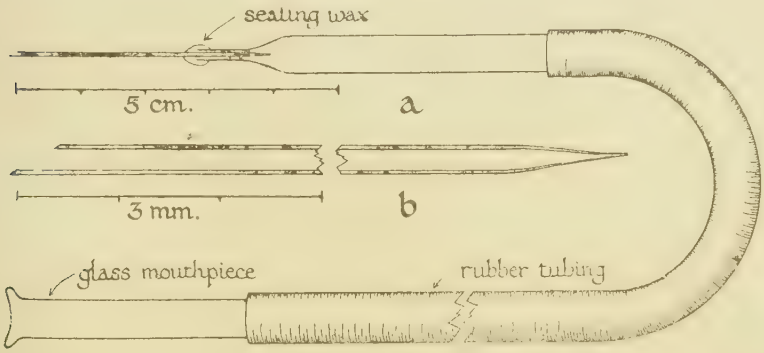

Figure 1. Construction of the compound micropipette used for injection. *a*, the completed instrument *b*, enlargement of the inner tubule.

Injections were made with compound micropipettes constructed as shown in figure 1, and manipulated as already described (Salt, 1955).

The pipette having been filled with insect saline, and a parasite egg or larva having been drawn into the tip, a host caterpillar was anaesthetized with ether and its cuticle perforated with fine scissors above the spiracle on the side of the eighth abdominal segment. The tip of the pipette was carefully inserted among the viscera and the parasite injected by a sudden puff of air. After withdrawal of the pipette, the wound was sealed with "New Skin." The hosts were kept at room temperature, which showed an average daily fluctuation between 17° and 19° C during December, when much of this work was done, and a maximum range of 13° to 28° C within the three months November to January. After a stated period of time, each host was dissected and the parasite retrieved for observation.

ROGAS IN *EARIAS INSULANA*

Injections of *Rogas* into its natural host *Earias insulana* were necessary as a test of the method, in order to show that eggs and larvae of the parasite can survive the manipulation and can develop in a host which has not been stung by their parent. A total of 19 injections were made into caterpillars of *Earias* in the fourth and fifth instars; 13 of eggs and 6 of recently hatched larvae of *Rogas*. When these hosts were dissected, 2, 3, 5, 7 or 11 days after the injection, the parasite larva in each was found to be alive and well. It had fed and developed, and had grown in proportion to the time elapsed since it was injected. As was to be expected, there was no sign of any defence reaction against these parasites.

A caterpillar of *Earias* collected in the field was found by dissection to contain a healthy *Rogas* larva 1.5 mm. long and also a small haemocytic capsule composed of transparent concentric lamellae. When this capsule was mounted and cleared, it could be seen to contain a shrivelled parasite larva which, judging from the mandibles, was probably a first-instar larva of *Rogas*. This observation shows that although the haemocytes of *Earias* appear to make no reaction to the living *Rogas* larva, they do react to a dead parasite.

One curious result remains to be reported. When *Earias* larvae in the fifth instar were injected with eggs of *Rogas*, they sometimes pupated before the parasite had time to develop. Four such pupae were formed and all were dissected but, in spite of the most careful search, no trace of the parasite could be found in them. It is certain that no parasite larva was present in these hosts, and it seems likely

that the injected eggs had never developed for, if the eggs had hatched, or even if the embryos in them had developed so far as to possess mandibles, it should have been possible to find and recognize the remains. *Rogas* eggs are normally laid in second- and third-instar caterpillars, and these observations suggest that the blood of a full-grown caterpillar preparing for pupation is unsuitable for their development.

ROGAS IN *PLATYEDRA GOSSYPIELLA*

For two reasons it was of special interest to observe the result of injecting *Rogas testaceus* from the spotted bollworm, *Earias insulana*, into larvae of the pink bollworm, *Platyedra gossypiella*. First, these two pests of cotton can occur on the same plant, so that a parasite seeking one may meet the other, and practical interest is attached to the question whether it is able to parasitize both of them. Second, Qadri (1933) has described another species of *Rogas*, *R. aligharensi*, as a parasite of the pink bollworm; and it is of interest to discover whether two related parasites avoid competition by attacking different hosts, or whether they are actually the same species attacking both hosts indiscriminately but differing to some extent in structure or colour according to the host in which they develop.

In two experiments each involving eight individuals, eggs of *Rogas* removed by dissection from small larvae of *Earias* were injected into full-grown caterpillars of *Platyedra*. They hatched, and the young larvae fed and developed for at least 4 days without any trace of a defence reaction on the part of the host. Indeed, the parasite larvae that were dissected out appeared so healthy that the remainder of the injected *Platyedra* were kept alive, in expectation that adult *Rogas* would eventually emerge from them. This expectation was confounded, for when the remaining bollworms were dissected, some as long as 31 days after their injection, the parasite larvae in them were found shrivelled and dead. They had been turned brown, presumably by a tyrosine reaction, and they were covered with a haemocytic capsule about 50 microns thick.

We have the situation, then, that for at least 4 days *Platyedra* makes no defence reaction to *Rogas*, which develops normally in it; but that none of the parasitized larvae left to develop yielded adult parasites. This recalls the remark made by Qadri (1933) in his original description of *Rogas aligharensi:* "In a few cases it was found that out of parasitised host larvae, adult parasit s failed to develop."

The shortness of my visit to Pakistan prevented further experiments to resolve these contradictory results, but some light can be thrown on the problem by considering the hosts. At the date of these experiments, late November until mid January, the only larvae of *Platyedra* obtainable were in a state of diapause. It is known that developing and diapausing larvae of *Enarmonia pomonella* react differently to parasites injected into them (Salt, 1955). I suggest that it was the diapause condition of the *Platyedra* that led to the death of the parasites, which were then encapsulated. The hatching and feeding of the parasite larvae in the early stages of the experiments suggest that when eggs of *Rogas* are injected into developing larvae of *Platyedra* they may be expected to survive. There is here a series of neat problems which I have discussed with my erstwhile pupil, Mr. M. Nazir Beg, and which I hope he may be able to solve.

ROGAS IN *SYLEPTA DEROGATA*

As stated by Muzaffer Ahmad (1943), females of *Rogas* readily attack larvae of *Earias* not only in their burrows but also when they are exposed on the surface of a cotton boll or bud. While seeking its hosts in such situations, the parasite may sometimes meet young larvae of another cotton pest, the leaf-roller, *Sylepta derogata*. Whether the *Rogas* then attacks and lays eggs in those larvae is unknown; but the following observations show that, if it does, the act is futile because the parasite progeny cannot develop in *Sylepta*.

Caterpillars of *Sylepta* that were approaching full size were injected each with one young larva of *Rogas testaceus* just emerged from the egg. When five of these caterpillars were dissected 24 hours after the injection, the parasite larvae in them were found to have been affected by both haemocytic and melanin reactions. The melanin reaction was the more consistent: all the larvae had a conspicuous black deposit over the mouth (fig. 2, a) and three of them also showed a dusky tinge on other parts of their surface (fig. 2, b). On four of these larvae there were aggregations of haemocytes, not forming a complete covering but attached in tattered shreds or irregular masses to parts of the surface (fig. 2, a, b). The fifth larva had no haemocytes attached to it when it was found but, as we shall see, it may have had some and

lost them. All these parasite larvae retrieved 24 hours after injection were not only alive but vigorously active although, their mouths being blocked, they had been unable to feed.

The remaining caterpillars were dissected 48 hours after injection. The small parasite larvae in them were still alive but much less vigorous than those retrieved after 24 hours. They had black deposits over the head region and a general discoloration, like a sepia-wash, over the whole surface. They were completely covered in an envelope of haemocytes about 30 microns thick (fig. 2, c).

Figure 2. Larvae of *Rogas* retrieved from *Sylepta*. *a* and *b*, young larvae retrieved after 24 hours. *c*, young larva retrieved after 48 hours. *d*, older larva retrieved after 24 hours. *e*, older larva retrieved after 4 days.

In the course of this experiment, one of the earliest carried out, my attention was attracted to the movements of the *Rogas* larva. It is able to make the bending and twisting movements common to most parasitic larvae and, in addition, by expanding some segments and contracting others, it can very considerably alter its proportions. Although it has a characteristic shape when at rest, the *Rogas* larva is able to change its outline far more than the first-instar larva of *Nemeritis*, which can do little more than bend and twist and straighten itself. For instance, it can withdraw its head into a basin formed by the thoracic segments. Now, this complicated writhing of *Rogas*, by altering the spatial relations of parts of its cuticle much more than is possible in the

simple bending and straightening of *Nemeritis*, must make it far more difficult for the haemocytes of the host to establish a continuous covering. This might well explain the absence of a haemocytic capsule and the presence of irregular masses and shreds on vigorous larvae retrieved 24 hours after injection.

These considerations suggested a further experiment. It seemed likely that if larvae of *Rogas* were allowed to feed for a day or two in the normal host, *Earias*, and were then injected into *Sylepta*, the food they had ingested might enable them to remain vigorous for a longer period and prevent capsule formation for some days.

In order to test this idea, larvae of *Rogas* about 0.6 mm. long, with an opaque area indicating the presence of ingested food in the mid-intestine, were dissected from caterpillars of *Earias*. By means of a micropipette of rather coarse bore they were injected into caterpillars of *Sylepta* that were nearly full grown. One of the caterpillars was dissected 24 hours later. The parasite larva in it was alive and vigorous but was apparently no longer able to feed for there was a dark deposit over its mouth and its pharynx was stained dark brown A mass of haemocytes of irregular shape was attached to the head and had on it five dark areas, one amber, three sepia, one nearly black, which had doubtless formed over the mouth but had been dislodged. A larger mass of haemocytes with an outline of lobes and shreds surrounded the hind parts of the parasite and stretched posteriorly (fig. 2, d).

Other larvae of this experiment, retrieved on the second and third days, followed the same pattern. A parasite larva examined 4 days after injection was still alive and vigorous but it had not grown. It had largely used up its reserves of food, for the mid-intestine was no longer opaque but transparent and mostly filled with bubbles of gas. The mouth was covered by a large transverse black deposit and the pharynx was completely blackened. Two brown stains on the thorax and one posteriorly indicated the beginnings of further melanization. A large mass of haemocytes amounting to about three times the volume of the parasite was attached to its side and posterior segments (fig. 2, e).

The course of events in this experiment is clear. Melanin deposits over the mouth within 24 hours prevented these larvae feeding; but they remained alive and vigorous, using up the food they had previously ingested, for at least 4 days. They attracted the haemocytes of the host,

which accumulated in large masses, as much as three times the volume of the parasite, but which were unable within 4 days to form complete capsules about them. This failure of the haemocytes to envelop and isolate the parasite can doubtless be attributed to the continued vigorous activity of these larvae, for it has been shown above that living but enfeebled larvae were completely enveloped within 48 hours.

In summary, it is clear that *Rogas testaceus* cannot develop in caterpillars of *Sylepta derogata* and that it evokes in them two defence reactions: a melanin reaction that blocks the mouth and prevents feeding, and a haemocytic reaction which is at first ineffectual but which eventually, after the parasite has become feeble, envelops it.

ROGAS IN *EPHESTIA SERICARIUM*

The parasite *Rogas testaceus* would not naturally come into contact with larvae of *Ephestia sericarium*, which is a pest of stored products and is usually found well away from cotton fields, in granaries and flour mills. Nevertheless, there is a practical interest in observing the interaction of *Rogas* and *Ephestia* for, if the parasitism were successful, it might be possible to rear large numbers of parasites in the laboratory and liberate them in the field, as is done with other species.

Fifteen caterpillars of *Ephestia sericarium* were injected with eggs or recently hatched larvae of *Rogas*. Seven of these caterpillars were dissected 3, 4, 5, 8 and 13 days after the injection. In all of them the *Rogas* larva was found alive and vigorous, its mid intestine opaque with food, and its size increased in proportion to the elapsed time. It was clear that the parasites were feeding and developing, to all appearances normally. None was haemocytosed or melanized.

On my return to the laboratory after an absence, the eight remaining caterpillars were found to form two groups. Of the first group, one caterpillar had died and putrefied; two remained as they were left; and one had pupated and later gave a female moth. The two caterpillars and the moth were dissected and in each of them was found a haemocytic capsule enclosing blackened debris which in one case, a caterpillar that had been injected with a larva, included recognizable mandibles of a first-instar larva of *Rogas*. In these individuals the parasite presumably died at, or soon after, injection and was encapsulated after death.

The remaining four hosts were more interesting. They were in part shrivelled, in part swollen; the swollen part had turned brown and was hard and brittle (fig. 3). At a glance it was clear that the cuticle of these four hosts had been modified as is the cuticle of *Earias* when *Rogas* pupates inside it. On closer examination, the swollen part of each was found to have a small concretion of material extruded through a hole, just like that pushed by the full-grown *Rogas* larva out of the skin of *Earias* (Muzaffer Ahmad, 1943, p. 201). It was obvious that the *Rogas* larvae had developed to their full growth in these unnatural hosts.

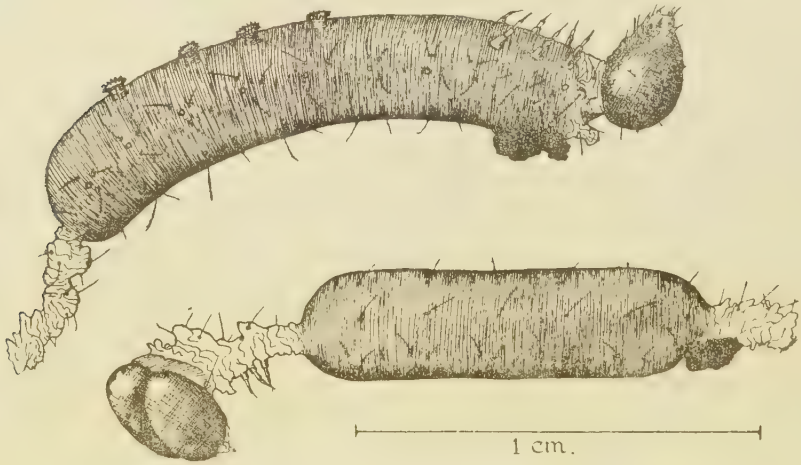

Figure 3. The appearance of larvae of *Ephestia* 24 days after injection with eggs of *Rogas*.

One of these individuals was carefully opened on the 34th day after injection and was found to contain a very large larva of *Rogas* completely filling the cavity and appressed to its walls, but the larva was motionless and apparently dead. The other three were kept, in the hope of rearing adult *Rogas* from them, but no emergence occurred and when at last they were opened they were found to be completely filled by *Rogas*, two by larvae, one by a pre-pupa, but all the parasites were dead.

It appears from this work that *Ephestia sericarium* makes no defence reaction to *Rogas testaceus*. The parasite is able to feed, grow, and develop to the pre-pupal stage in them, and to induce the

transformation of the cuticle to a puparium, but is unable to pupate in them. The reason for this ultimate failure may be simply a matter of size, for the *Rogas* larva must eat the contents of its host in order to make space for its pupation and to produce the conditions necessary for the drying of the host's cuticle. The full grown caterpillars of *Ephestia* used in these experiments were a good deal larger than third- and early fourth-instar caterpillars of *Earias*; and the parasites found in them had grown to more than three times the normal size of full-grown *Rogas* larvae. It may be that if immature *Ephestia* larvae were injected or, better still, *Rogas* could itself be induced to parasitize small *Ephestia* larvae, the parasite could come through on this host.

DISCUSSION

From an ecological point of view, interest in this brief study centres on the comportment of *Rogas* in relation to a group of lepidopterous larvae found on cotton. The adult parasite seeking its natural hosts, young spotted bollworms of the genus *Earias*, must come across caterpillars of other species, certainly of *Platyedra*, in some regions of *Sylepta*, and probably of several other species of Lepidoptera that commonly occur on cotton. Whether the parasite attacks those other species in nature has never been directly investigated, although it would make an interesting study in parasite behaviour. Some indirect observations made during my visit to Pakistan will be incorporated in another paper. But the experiments recorded here show that if and when *Rogas* attacks *Sylepta*, it wastes the eggs it lays, for they cannot develop in that host. On the question of the pink bollworm, however, the present experiments are inconclusive, for a freely ovipositing *Rogas* would lay in young developing caterpillars while these experiments were necessarily done with full-grown caterpillars in a state of dormancy. For the several reasons given above a further study of *Rogas testaceus* in relation to *Platyedra* would be likely to give interesting results.

From the point of view of parasitology, it is of interest to find that *Sylepta* reacts to *Rogas* with the same pair of defence reactions as a great variety of hosts use against *Nemeritis*. No new type of defence reaction was observed during this work. But the study of *Rogas* in *Sylepta* does give rise to a set of considerations not raised by studies of *Nemeritis*, that is, to the reaction of the parasite to the defence reactions of the host. The parasite *Nemeritis* is completely

enveloped in caterpillars of *Diataraxia* within 4 hours, and so thickly encapsulated as to be unable to bend in about 12 hours (Salt, 1959). But the *Rogas* larva in *Sylepta* seems to be able to ward off complete encapsulation as long as it can remain vigorous, young larvae were not enveloped until the second day, larvae that had been able to obtain a reserve of food were not surrounded even by the fourth day. This cannot be attributed to failure of the haemocytes to mobilize, for they accumulated in large masses. It appears to be due simply to the writhing movements and changes of shape of which the *Rogas* larva is capable. Other reactions to defence reactions may well be found when more parasites have been studied in this way.

SUMMARY

Eggs or recently hatched larvae of the braconid parasite *Rogas testaceus* were injected into caterpillars of four species of Lepidoptera. In *Earias insulana*, the natural host, no defence reactions were observed and the parasite larvae developed normally except in the case of eggs injected into fifth-instar caterpillars about to pupate, when the parasites failed to develop. In *Platyedra gossypiella* no defence reactions were observed but no adult parasites were reared, perhaps because the hosts used were in diapause. In caterpillars *Sylepta derogata* a melanin reaction blocked the mouth of the parasite larva within 24 hours and haemocytes accumulated about it but did not form a capsule until the parasite was enfeebled. Caterpillars of *Ephestia sericarium* made no reaction to the parasite, which completed its larval development in them but was unable to pupate and emerge. Attention is drawn to the significance of the movements of *Rogas* larvae in preventing capsule formation.

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Muscular system of *Drosicha stebbingi* (Green)
(Coccidae : Homoptera)

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INTRODUCTION

Drosicha stebbingi (Green) is a common pest of fruit and shade trees in West Pakistan. Although much is known about its biology, taxonomy and control, very little work has been done on its anatomy. Savage (1914) studied its respiratory system. Latif (1950), Latif & Chaudhry (1956a, 1956b), Latif & Alam (1959), Latif & Khan (1959) and Latif & Saeed (1959) have described the digestive and nervous systems of the female and flight muscles of the male. Musculature of the female of this insect is being described in the present paper.

Some work on the myology of insects, particularly of those belonging to a primitive order, has been done by Berlese (1909), Snodgrass (1928), Imms (1939), Jannone (1940), Misra (1945, 1946, 1947) and La Greca (1947). But very little information is available on the musculature of insects belonging to higher orders like Hemiptera. Beckee (1929) and Rawat (1939) described the muscular system of *Naucoris cmicoides* Linn. Akbar (1956) has attempted to describe the musculature in *Leptocorisa varicornis* Fabr. The present study is an attempt towards describing in detail the muscles, both extrinsic and intrinsic, of the female of *D. stebbingi*.

MATERIAL AND METHOD

For the study of the musculature the insects were dissected after killing them in the cyanide bottle. A good deal of difficulty was encountered in exposing the muscles due to the so-called fatty material in the body of this insect. All commonly known fat solvents like xylol, ether, carbon tetrachloride, choloroform, benzene and alcohol were tried to dissolve the fatty substance, but without any appreciable success. Ordinary tap water proved to be the best for slow and gradual washing of the fatty substance to expose the muscles. It was further found that

treatment with 90% alcohol after dissecting the insect in water was very helpful in clearing the musculature as it caused swelling of the muscles, which thus became prominent and easily traceable. A new technique for differential staining of the muscles has been evolved. This differentiates the red muscles from the yellow tissue of body. According to this technique the specimens were dissected in water and dehydrated in ascending grades of alcohols. Jeners solution, prepared in 90% alcohol and kept for 48 hours before use, was employed for staining the specimens. Staining was done for 5 minutes whereafter the excess of stain was washed away with 90% alcohol.

The specimens were then kept for 10 minutes in rectified alcohol to which a few drops of methyl salicylate were added. There was no need for treating the specimens in absolute alcohol or in clove oil or cedar wood oil, as they were dehydrated and cleared sufficiently by following the aforementioned procedure.

For histological studies the insects were dissected alive and fixed in Bouin's fluid for about 30 minutes. The specimens were dehydrated in alcohol and then cleared in cedar wood oil for 24 hours and transferred into paraffin wax for embedding. Sections, 8 micron thick, were cut with a Cambridge rocking microtome and were stained with Delafield's haematoxylin and Eosin.

Figures were drawn with the help of Camera Lucida and microphotographs were taken on phase microscope and Beck 47 model, each fitted with Leica camera. All other drawings are diagrammatic.

I. MUSCLES OF THE HEAD AND ITS APPENDAGES

1. MUSCLES OF THE HEAD

(a). Muscles of the antennae

(i). ELEVATORS OF THE ANTENNAE (elAnt) Fig. 1. These are a pair of muscles, each component of which arises from the outer aspect of the respective anterior arm of the tentorium a little below its anterior extremity. These are inserted on the basal rim of the scape. One of these muscles is inserted at a point on the laterodorsal aspect of the rim and the other at a point at its lateroventral aspect.

(ii). DEPRESSORS OF THE ANTENNAE (dp Ant) Fig. 1: This is also a pair of muscles and lies inner to the elevators. Each component of this pair originates a little anterior to the elevator of its side from the anterior extremity of the anterior arm concerned of the tentorium. They are inserted one on the laterodorsal aspect and the other on the ventrodorsal aspect of the basal rim of the scape.

(iii). EXTENSORS OF THE ANTENNAE (exAnt) Fig. 2: These are a pair of muscles originating from the base of the scape; one arising from the dorsal aspect of the inner angle of basal rim of the scape and the other arising from the ventral aspect of basal rim of the said segment. Both of these are inserted on the same point, situated on the inner distal margin near the medial angle of the scape.

(iv). RETRACTORS OF THE ANTENNAE (rtAnt) Fig. 2: These are a pair of muscles originating from the base of the scape. One of them arises from the dorsal aspect of the outer angle and the other from the ventral aspect of the inner angle of the said segment. Both of these are inserted on a common point situated on the distal margin near the outer lateral angle of the scape.

(b). Muscles of the tentorium

(i). ELEVATORS OF THE TENTORIUM (elTnt) Fig. 1: This pair of muscles arises from the antero-lateral wall of the epicranium. Its components are wider near their points of origin. Each of them passes down to be inserted on the anterior arm of the tentorium (AT) of its side.

(ii). DEPRESSORS OF THE TENTORIUM (dp Tnt) Fig. 1: This is a pair of muscles, the components of which after arising from the right and left lateral extremities of the caudodorsal border of the head, travel forward antero-medially till each touches outer lateral aspect of the anterior arm of the tentorium (AT) of its side a little below the anterior extremity of the arm concerned, and gets inserted there.

(2). MUSCLES OF THE MOUTH PARTS

(a). Muscles of the sucking pump

DILATOR MUSCLE OF SUCKING PUMP (dlcb) Fig. 3: This a large fan shaped muscle originating from a greater part of the inner clypeal surface Clp. It travels dorso-ventrally. It becomes narrowed and compact distally and gets inserted on the anterior convex sclerotised wall of the sucking pump (pmp). A closer examination of this muscle towards the

distal end near the surface of insertion shows that it is in fact composed of two component bands. By the contraction of this muscle anterior inner wall of the sucking pump is lifted up causing a cavity to be formed in the tube of the sucking pump; in this way the upward suction through the tubular entrance to the chamber is affected. On the relaxation of this muscle the lifted wall springs back into the lumen by the force of its own elasticity, its lower end descending first. The liquid food is drawn into the chamber from the food canal by this mechanism and is pushed into the anterior part of the stomodaeum. This muscle corresponds to the fan shaped 'divaricator muscle' of *Nepa*, 'First dilator (dlcb)' of *Oncopeltus* and 'dilator of sucking pump' of *Pyrilla* described by Hamilton (1931), Snodgrass (1935) and Butt (1943) respectively, (vide Akbar, *loc. cit)*. No other accessory dilator muscle could be seen in *D. stebbingi*. similar to that described in the case of *Leptocorisa varicornis* by Akbar *(loc. cit.)*.

(b). Muscles of the salivary syringe

These (dlsyr, Fig. 4) are two well formed dilator muscles originating from the inner border and medial surface of each one of the hypopharyngeal wings (HphyW). These are disposed ventro-dorsally. They travel posteriorly and obliquely and converge to meet at their common point of insertion which is the anterior end of the slender apodeme present on the dorsal side of the knob of the piston (pn) of salivary syringe (syr). The mechanism of these muscles is very simple. Their contraction lifts the end wall of the salivary cup and the latter springs back to its normal position by its own elasticity, resulting in the suction of salivary liquid into the chamber of the cup through the salivary duct. At the same time liquid is forced out through the outlet tube by the downward movement of the piston caused by the relaxation of these muscles.

(c). Muscles of the mandibular bristles

These (Fig. 5) are two groups of muscles, paired protractor (pmdb) and paired retractor (rtmdb) muscles for each mandible. The same has been referred to by Akbar (*loc. cit.)* as 'mandibular sac'. Laterally on its outer aspect and near its proximal end each mandibular plate is joined to the tip of the lower arm of the 'Y' shaped mandibular lever (mdlvr). The upper arm of the mandibular lever is free and bears the insertion apodeme of the first band of the protractor muscles (1 pmdb) of the mandible which originates along the inner border of the posterior

tentorial arm (PT) as well as from the basal portion of the anterior tentorial arm (AT). The other band of protractor muscles (2 pmdb) of the mandible takes its origin along the inner border of the ventral median plate of the inner cephalic capsule wall. These muscles are inserted on the lower arm of the 'Y' shaped manbibular lever (mdlvr) on its ventral aspect. Both these muscles are broader near their origin and get slightly narrowed down when approaching their respective points of insertion. The other set of muscles is the retractors of the mandibles. They too consist of two groups of the muscles. The larger band takes its origin along the inner margin of the dorsal apodeme situated on the dorso-medial aspect of the inner cephalic capsule which is chitinised and slightly folded posteriorly. This group of muscles narrows down to its point of insertion located on the dorsal outer aspect of the proximal end of the mandibular plate. The other component of the retractor muscles (2 rtmdb) originates from the wall of the inner cephalic capsule a little posteriorly to the bigger muscle (1 rtmdb) just mentioned. It gets considerably narrowed down towards the point of insertion which is also situated on the outer corner of the base of the mandibular plate close to its point of junction with the lower arm of the mandibular lever. The contraction of the protractor muscles pushes down the mandibular stylets into the tissue and by the relaxation of their said muscles, assisted by the contraction of the retractor muscles, the mandibular stylets are taken out of the tissue.

(d). Muscles of the maxillary bristle

As in the case of muscles of the mandibular stylets, two sets of muscles of each type, protractor and retractor are related to the two maxillae (Fig. 6). Thus there is one set of protractor muscles and another of retractor muscles for one maxilla and a similar set of these muscles for the other maxilla. For convenience protactor and retractor muscles of maxillae of one side will be described.

(i). PROTRACTOR MUSCLES OF MAXILLA (pmxb) Fig. 6: This muscle is roughly triangular in shape. It originates from the ventro-medial aspect of the wall of the inner cephalic capsule and is directed upward. This muscle (pmxb) is inserted on the outer lateral margin of the maxilla throughout its length within the head capsule. It is seen slightly overlapped by some bands of the protractor muscles of the mandible (pmdb, Fig. 5), the latter being disposed slightly at an angle to the former.

(ii). RETRACTOR MUSCLES OF THE MAXILLA (rtmxb) Fig. 6 : This fan shaped muscle has a wide base which arises from the dorsolateral aspect of the inner cephalic capsule. It narrows down considerably when approaching its point of insertion, which is the proximal end of the maxillary plate (Mxp).

The contraction and relaxation of the protractor and retractor muscles respectively pushes down the maxillary stylets into the tissue, while the maxillary stylets are taken out by the reverse action of the aforementioned muscles.

(e). Muscles of the labium

There are different sets of muscles in the labial segments (Fig. 7). They perform such functions as contraction of the various segments, the regulation of the passage of the stylets in bristle clamp (Cla), etc. In *D. stebbingi* the following sets of muscles are discernible in the labium.

(i). EXTRINSIC ABDUCTOR MUSCLES OF LABIUM (eadLb) Fig. 7: These are a pair of thin muscles arising from the side of the anterior margin of the dorsum of the first thoracic segment. Each of these muscles passes downward and forward to its point of insertion which is situated in the centre of the proximal edge of the 'L' shaped piece of its side on the third labial segment (Post labium).

(ii). EXTRINSIC ADDUCTOR OF LABIUM (eabLb) Fig. 7 : This is a pair of thin and long muscles arising from the anterior margins of the pleura of the first thoracic segment. These also extend downward and forward and each component gets inserted on a tendon situated on the anterior band of the 'L' shaped piece of its side on the third labial segment (Post labium).

(iii). INTRINSIC ADDUCTOR MUSCLE OF LABIUM (adLb) Fig. 7: This muscle consists of a rectangular band of two fibres which take their origin from the anterior edge of the second labial segment on the right side a little distance medially from the extremity of the edge. These are directed towards the posterior side more or less in a vertical plane and become inserted on the junction of the first and second segments of labium (Pre labium).

(iv). TRANSVERSE MUSCLES OF THE SECOND LABIAL SEGMENT (tmLb) Fig. 7: These are three muscles inserted on the bristle clamp (Cla). One is disposed on the right side and the remaining two on the left side of the said clamp. The one on the right side (tmLb 1) consists of three fibres. It originates from the middle portion of the right half of the anterior margin of the second labial segment (Pre labium). Its base is broad and occupies about one half of the total length of the anterior margin of the second labial segment. It travels obliquely and proceeds postero-medially till it gets inserted on the posterior half length of the bristle clamp (Cla) in the second segment. The insertion end of the muscle is slightly narrower than the base.

The second set of these muscles (tmLb 2) is disposed almost opposite to the first one on the left side of the clamp. Its point of origin is a little distance away from that of the bristle clamp on the anterior margin of the second labial segment and its surface of origin is almost half in length of the total surface of the anterior margin of the second segment on the left side of the clamp. This muscle consists of three fibres and it travels obliquely and postero-medially like the first set and gets inserted on the left aspect of the bristle clamp, its surface of insertion occupying almost half of the length of the clamp in the middle of the second labial segment.

The third set of muscles (tmlb 3) originates from almost the entire left lateral edge of the second labial segment. It consists of three fibres and travels obliquely and antero-medially till it gets inserted on the left aspect of the bristle clamp. Its surface of insertion is slightly narrower than that of its origin and it occupies the anterior half length of the clamp in the second labial segment.

(v). RETRACTORS OF THE TERMINAL LABIAL SEGMENT (rtlb) Fig. 7 : These are two muscles, one on the right side and the other on the left side of the bristle clamp (Cla) in the second labial segment. Tne first (1 rtlb) of these two muscles originates from the right aspect of the posterior half length of the wall of the clamp in the second segment. It consists of three fibres and it travels postero-laterally till it gets inserted on the wall of the labial groove (Lbg) above the point of junction of the second and third labial segments. The second muscle (2 rtlb) originates from the left lateral aspect of the second labial segment and its point of origin occupies almost the entire length of the said aspect. It consists of three fibres and it travels postero-medially till it gets inserted on the surface of junction of the pre-labial segment in the left half of the second labial segment. Its surface of insertion is little narrower than that of its origin.

II. MUSLES OF THE THORAX AND ITS APPENDAGES

Musculature of prothorax can be discussed mainly under two heads, the muscles of pronotum and those of prosternum.

1. MUSCLES OF PROTHORAX

(a) Muscles of pronotum

(i). FIRST PAIR OF LEVATORS OF HEAD (1lvH) Fig. 8. These are four fan shaped muscles originating two on each side from the inner proximal parts of a longitudinally placed ridge (R) situated perpendicularly to the anterior border of protergum of the side concerned. These are broad at their points of origin and get gradually narrowed till they reach their points of insertion which are situated on the post-occipital region (Pocr) of the inner cephalic capsule.

(ii.) SECOND PAIR OF LEVATORS OF HEAD (2 lvH) Fig. 8. These are two thin muscles, one on each side. Each of them originates from the posterior side of the longitudinal ridge (R) mentioned already under the first pair of levators of head (1 lvH) of the side concerned. These are disposed anteromedially and get inserted below the first pair of levators on post-occipital region (Pocr) on each side.

(iii). INDIRECT LEVATORS OF HEAD (ilvH) Fig. 8. These are a pair of wall developed muscles, obliquely disposed between the post occipital region (Pocr) of the head and the anterior side of the ridge bordering the mesonotum proximally. Each of these muscles arises a little away from the centre of the anterior border of the prescutal ridge (R) on the side concerned. Both these muscles are directed antero-medially and ultimately they converge to lie side by side at the points of their insertion which are situated on the posterior side of the post-occipital region (Pocr) below the respective points of insertion of the second pair of levators (2 lvH) of the head on the two sides.

(iv). DEPRESSORS OF PRONOTUM (dppn) Fig. 8. These consist of a set of four muscles on each side. They are disposed postero-anteriorly on the bulk of the under surface of protergum, starting from the extreme lateral aspect of side concerned and going inwards the muscles of each set have been mumbered as 1, 2, 3 and 4. The first muscle of each side is well developed. Arising from the extreme anterolateral margin of the prescutal ridge (R) of the side concerned, it is directed antero-laterally in a horizontal plane and becomes inserted on the angular ridge

(R') along its postero lateral margin. It is a band of wide muscles. The second muscle of each set takes its origin a little inner and adjacent to the first muscle from the anterior margin of the prescutal ridge (R). Its disposition is similar to that of the first muscle and it gets inserted on the posterior aspect of the angular ridge (R') at about its middle. The third and fourth muscles of each side lie mediad to the first two, close to each other. Muscle No. 3 takes its origin medially to and near the base of the second muscle. At its point of origin it overlaps a part of the base of the indirect levator of head of its side. It is directed antero laterally but is shorter in length as compared to the first two muscles. It becomes inserted on a depression of the protergum at about its middle. Muscle No. 4 is the smallest muscle of the set and it lies innermost. It originates from about the middle of the prescutal ridge (R) on its anterior border. It travels almost parallel to muscle No. 3 and becomes inserted on a depression on the main surface of the protergum inner to, but at a lower level than, the insertion of the third muscle. Malouf (*loc. cit.*) suggests that the morphological nature of this muscle is obscure and prefers to call it an highly individualised muscle produced possibly in response to structural modificatins of the prothorax.

(v). RETRACTORS OF PROFURCA (rtFu 1) Fig. 8. They are a pair of elongated bundles of muscle fibres. Each component of the pair originates from the lateral extremity of prescutal ridge (R) of its side. These muscles are directed more or less horizontally from the respective sides from which they originate and pass downward to the sternum. Each one of them getting inserted on the under side of the prothoracic furcal arm of its side. Akbar (*loc. cit*)., while describing musculature of *L. varicornis*, states that the retractors of propectus indirectly elevate the head of the insect mentioned above, but asserts that these correspond to the "tergo-sternal. furcal" of *Nezara* described by Malouf (1932). The latter muscle as stated by Malouf *(loc. cit)*., however, indirectly protracts the fore-legs. Since no connection of this muscle with the legs has been noticed in the case of *D. stebbingi*, the present writers agree with Akbar *(loc. cit)*. in asserting that it indirectly elevates the head.

(vi). LABIAL DORSO-VENTRAL MUSCLE (LbdvM) Figs. 8 & 9. This is a pair of long and slender muscles. The fibres of each component of the pair arise from the extreme antero-lateral aspect of the prescutal ridge (R). It is directed dorso-ventrally to its point of insertion which is situated on the third segment of the labium. This muscle functions as an abductor of the labium.

(vii). OCCIPITAL DORSO-VENTRAL MUSCLES (Ocdvm) Figs. 8 & 9. These are a pair of medium sized elongated muscles. Each component of the pair takes its origin from anterior aspect of the elbow of the angular ridge (R', Fig. 8). It is directed medio-ventrally and gets inserted on the lateral outer aspect of the occipital area of the inner cephalic capsule on the side concerned. Incidentally, it may be mentioned that these muscles do not occur in any of the bugs described by other workers, hence Akbar (*loc. cit.)* and Malouf (*loc. cit.)* have not described them.

(viii). FIRST PROMOTORS OF COXAE (1 PrCx) Figs. 8 & 9. These are a pair of large muscles serving the coxae. Each component of the pair originates mesially from the outer aspect of the angular ridge (R') and is disposed perpendicularly to the anterior border of protergum. This muscle is wide at its point of origin. It is directed ventrally and becomes narrow towards its point of insertion which is situated on the apodeme near the trochantin.

(ix). SECOND PROMOTORS OF COXAE (2 PrCx) Figs. 8 & 9. This pair of medium sized muscles serves the coxae. Each component of the pair lies below the occipital dorso-ventral muscles (OcdvM) and like the latter it takes its origin from the outer aspect of the elbow of the angular ridge (R', Fig. 8) and gets inserted at a point close to the insertion of the first promotor of coxa (1 Pr Cx). It is much smaller than the first promotor of coxa.

(b). Muscles of prosternum

(i). DEPRESSORS OF HEAD (dpH) Fig. 9. This is a pair of small fan shaped muscles each originating medially from the anterior aspect of coxa and directed antero-medially till it becomes inserted near the anterior tentorial arm (AT Fig. 1).

(ii). DEPRESSO-EXTENSORS OF HEAD (dpeH) Fig. 9. These are also a pair of small muscles. Each muscle originates from the anterior arm of the first thoracic furca (Fu 1) of its side, is directed antero-medially and becomes inserted as a narrow band above the loral plate of the inner cephalic capsule of its side.

(iii). THIRD PROMOTORS OF COXAE (3 PrCx) Fig. 9. It is a pair of small muscles to serve the coxae. Each component of the pair originates along the inner aspect of a black oblique ridge (OR) situated antero-laterad to the coxa and is inserted as a narrow muscle on the rim of the coxa (Cx). On account of its small size, it looks triangular in shape.

(iv). REMOTORS OF COXAE (RemCx) Fig. 9. These are two muscles, one for coxa of each side. Each component of the pair originates as a wide muscle from the inner aspect of the furcal arm and is directed antero-laterally to become inserted as a narrow bend on the postero-lateral aspect of coxal base.

(v). PROMOTO-EXTENSORS OF HEAD (PreH) Fig. 9. It is a pair of small muscles. Each component of the pair originates from the inner aspect of a vertical ridge of the side concerned, and is directed medially to be inserted as a narrowed band on the postero-lateral aspect of the inner cephalic capsule.

2. MUSCLES OF MESOTHORAX

Previous workers have variously treated the muscles of the mesothorax in insects. This variation is probably correlated with the various modifications, in the structure of the mesothorax that has undergone in insects. In general, some workers have omitted their account presumably because they never considered these muscles important and hence have dealt with only those muscles in this segment that are concerned with flight. This is the probable reason why Akbar (*loc. cit)*. has omitted the discussion of all muscles of meso- and metathorax and those of flight and extrinsic leg muscles in *L. varicornis*. Another point which has to be borne in mind is that in certain insects both alate and apterous forms exist. The arrangement of thoracic muscles in these cases is apt to be different in the two forms. The arrangement of muscles in the case of *Schizoneura americana* described by Miller (1933) is a case in point. In the case of *D. stebbingi* (Gr). also there is dimorphism. The females are apterous and the males winged. Therefore, it has been considered essential to discuss the musculature of mesothorax in the male and female separately. The flight muscles of mesothorax (which is the only wing bearing segment) in the male have been dealt with in a separate paper by Latif & Khan (1959). The account that is to follow is of the musculature of mesothorax of the female. Since the wings are absent in this case the muscles discussed are the general muscles of the segment and not those of flight, which are wanting.

Because of the apterous condition in female the meso- and metathoracic segments have become specially modified. The muscles of mesothorax are discussed under two categories, the muscles of mesonotum and those of mesosternum.

(a). Muscles of mesonotum

(i). DORSAL MEDIAN MUSCLES (DmM) Fig. 10. It is a pair of medium sized vertically disposed muscles. These muscles are situated medially one on each side of, and a little laterad to the imaginary median longitudinal line in the tergum. Each of these muscles originates from the posterior border of the prescutal ridge (R) of its side and is directed posteriorly and becomes inserted on the anterior border of the mesoscutal ridge (S) on the side concerned.

(ii). DORSO-LATERAL MEDIAN OBLIQUE MUSCLES (DlmoM) Fig. 10. This is a pair of muscles each component of which originates close to the point of origin of the dorsal median muscles of its side and a little outer to it. Each muscle is disposed postero-laterally and becomes isnerted near the lateral extremity of the mesoscutal ridge (S).

(iii). MAJOR LATERAL MUSCLES (mjlM) Figs. 10. These are a pair of strongly developed and wide muscle bands. Each component of the pair is situated laterad and outer to the dorsolateral median oblique muscles of the side concerned. Some fibres of each of these muscles originate from the under side of the lateral terminal end of the prescutal ridge (R) and the rest of them originate from depressions located still outer to the point of origin of the former fibres. These muscles are directed posteriorly and become inserted on the anterior border of the narrow lateral extremities of the meso-scutal ridge (S) outer to the points of insertion of the respective dorso-lateral median oblique muscles (DlmoM).

(iv). DORSO-LATERAL OBLIQUE MUSCLES (DloM) Fig. 10. Each component of this pair of muscles originates from the depression situated outer to the point of origin of major lateral muscles. It is slanting in disposition and is directed antero posteriorly and becomes inserted on the terminal lateral thinned out portion of the posterior margin of tergum.

(v). FIRST PROMOTORS OF COXAE (1 PrCx') Fig. 10. These are a pair of well formed muscles. Each component of the pair consists of three fibres which originate from three points situated one behind the other on the imaginary transverse line running in the middle of the mesoscutum almost under the dorso-lateral oblique muscle (DloM). These muscles are directed dorso-ventrally. Towards their point of

first insertion which is situated on the apodeme on the distal margin of the coxa they become narrow. These muscles like other leg muscles to be described shortly pass through the apodeme and reach their second point of insertion which is on the cutical near the centre of the coxal base.

(vi). SECOND PROMOTORS OF COXAE (2 PrCx') Fig. 10. This pair of muscles is probably unique in *D. stebbingi* as none of its type has been described in other Hemiptera studied by workers like Malouf *(loc. cit.)* Miller *(loc. cit.)* and Akbar *(loc. cit.)* Each component of this pair originates on its respective side from a depresssion disposed laterad to but in line with the prescutal ridge (R) and is directed dorso-ventrally till it becomes inserted first on the apodeme referred to in the case of the first promotors of coxae and thereon the antero-lateral margin of the coxal base. It may be mentioned here that this muscle becomes somewhat angulated while passing through the aforementioned apodeme.

(vii). TERGAL DEPRESSORS OF TROCHANTERS (Tdptr) Fig. 10. These are a pair of well formed muscles. The fibres of each of these muscles originate posterior to the origin of the first promotor muscle of the leg close to the insertion of dorso-lateral oblique muscles of the side concerned. Each of these muscles is directed dorso-ventrally towards the aforementioned coxal apodeme of its side where it has its first insertion. It then proceeds through the apodeme and is deflected towards the postero-lateral margin of the coxal rim where it is finally inserted.

(viii). FIRST REMOTORS OF COXAE (1 Rem'Cx) Fig. 10. These are a pair of elongated muscles each of which originates from near the base of the tergal depressor of trochanter (Tdptr) of the side concerned. Each muscle is directed dorso-ventrally and gets inserted on the latero-posterior aspect of the coxal rim close to the insertion of tergal depressor of trochanter of its side.

(b) **Muscles of mesosternum**

(i). VENTRAL LONGITUDINAL MUSCLES (VlgM) Fig. 11. These are a pair of muscles each of which is formed of two bands of fibres. Each muscle originates from the posterior border of the profurca (Fu 1) and

its point of origin occupies about the entire half of the surface of the border of its side. It then travels postero-medially along the surface of the mesosternum and is progressively narrowed down till it gets inserted on the antero-lateral aspect of the mesofurca (Fu 2).

(ii) FIRST AND SECOND OBLIQUE MUSCLES (ObM) Fig. 11. These are two pairs of muscles, a pair on each side. The inner components of the pair on each side constitute the first pair of these muscles (1ObM) and the outer ones the second pair (2 ObM). The points of origin of these muscles are situated close to each other on each side of the body on the anterior border of the meso-sternum a little away from its lateral extremity. The components of each pair on each side of the body travel in an oblique fashion and parallel to each other in a postero-medial direction till they get merged into each other near their point of insertion on the antero-lateral margin of meso-furca (Fu 2) underneath the point of insertion of the respective ventral longitudinal muscle (VlgM) of mesosternum of the side concerned.

(iii). THE FURCAL PLEURAL ARM MUSCLES (FuplM) Fig. 11. [Pleuro-sternal muscles of Snodgrass (1935)]. This is a pair of elongated muscles, each of which originates laterally on the mesofurca (Fu 2) and is directed outward almost entirely in a lateral direction with a slight disposition anteriorly till it gets inserted on an apodeme near the junction of the sternum and tergum on the side concerned.

(iv). SECOND REMOTORS OF COXAE (Rem'Cx) Fig. 11. This is a pair of medium-sized muscles each of which originates from the lateral aspect concerned of the tip of the proximal meso-furcal apodeme. The base of each muscle is narrow and it becomes progressively wider as it travels almost straight laterally and gets inserted on the inner medial surface of the coxal rim.

(v). FIRST EXTRA-COXAL DEPRESSORS (ECxDp 1) Fig. 11. This is a pair of small muscles each of which originates from a point almost centrally located in the outer one third of mesosternum of the side concerned. Each of these muscles is directed postero-medially and becomes inserted on the outer lateral aspect of coxal rim.

(vi). SECOND EXTRA-COXAL DEPRESSORS (ECxDp2) Fig. 11. This is a pair of muscles each of which originates on the lateral aspect concerned of the proximal meso-furcal apodeme, a little below the point

of origin of the remotor of coxa of its side and is directed laterally and slightly posteriorly till it bifurcates near its insertion on the coxal rim a little posteriorly to that of the first extra coxal depressor muscle of its side.

(vii). STERNAL DEPRESSORS OF COXAE (SdpCx) Fig. 11. [Sternal remotors of coxae according to Snodgrass (1935)]. This is a pair of well developed muscles each of which originates as wide band on the postero-lateral aspect concerned of mesofurca (Fu 2) and is directed laterally becoming slightly narrow towards its point of insertion on the inner posterior aspect of the coxal rim of its side.

3. MUSCLES OF THE METATHORAX

The muscles of metathorax can be discussed under two heads, the muscles of metanotum and those of metasternum.

(a). Muscles of metanotum

(i). DORSAL MEDIAN MUSCLES (DmM 2) Fig. 12. These are a pair of muscles which in their structure and disposition correspond to their counterparts in the mesothorax (DmM). Thus each of these is medium sized and vertically disposed and originates from the hinder margin of the mesoscutal ridge (S). Each is directed posteriorly till it becomes inserted on the metascutal ridge (T). As in the case of their counterparts in the mesothorax these muscles are situated one on either side of the imaginary mid-longitudinal line on the metanotum a little distance away from it, but running parallel to it on either side.

ii). DORSO-LATERAL MEDIAN OBLIQUE MUSCLES (DlmoM 2) Fig. 12. As is the case with the dorsal median muscles, the dorso-lateral median oblique muscles can be readily compared with their counterparts (DlmoM, Fig. 10) in the preceding segment. Each of these muscles takes its origin laterad to but near the origin of the dorsal median muscle of its side. It then runs postero-laterally till it reaches its point of insertion on the anterior border of the metascutal ridge (T) on the side concerned. These muscles are larger than the dorsal median muscles.

(iii). MAJOR LATERAL MUSCLES (mjlM 2) Fig. 12. This pair of muscles also correspond in their structure to their counterparts of the mesothorax (mjlM, Fig. 10). These consist of strongly developed wide

muscle bands. Each of these muscles originates from the lateral extremity of the posterior aspect of the mesoscutal ridge (S) on the side concerned and runs straight posteriorly till it becomes inserted on the lateral extremity of the anterior margin of the metascutal ridge (T) of that side.

(iv). OBLIQUE INTERSEGMENTAL MUSCLES (OiM) Fig. 12. These are two pairs of muscles; there being one pair of these on each side of the metanotum. Muscles similar to these have not been observed in the first two thoracic segments. The two components (a and b) of each pair of these muscles on either side of the body have their points of origin close to each other on the intersegmental fold laterad to the mesoscutal ridge (S), on the side concerned They are directed postero-medially to become inserted on the lateral extremity of the metascutal ridge (T) of their side at a common point.

(v). FIRST PROMOTORS OF COXAE (1 Pr' Cx') Fig. 12. There is a pair each of these muscles on either side of the metatergum. The anterior component (a 1) of the pair of side is longer and stouter than the posterior component (b 1). The point of origin of a 1, is adjacent to and touching that of the oblique intersegmental muscle 'a' and that of b 1, is a point a little distance posterior to that of a 1. These muscles travel dorso-ventrally till they get inserted adjacent to each other on the apodeme of the trochantin of their side.

(vi). FIRST REMOTORS OF COXAE (1 Rem'Cx') Fig 12. These two are a pair of muscles on each side of the metatergum. The components of a pair of one side have been termed a2 and b2 for reference. The muscle a2 originates a little postero-medially to the point of origin of b 1 of first promotor muscle of coxa of the side concerned and the muscle b 2 originates more medially from a central point on the metatergum between the major lateral muscle (mjlM 2) and component 'b' of pair of oblique intersegmental muscles (OiM) of the side concerned. Both travel dorso-ventrally and get inserted on the coxal apodeme of their side at a common point.

(vii). TERGAL DEPRESSORS OF TROCHANTERS (1 Tdptr) Fig. 12. It is a pair of long thin muscles each originating from the extreme lateral aspect of the metascutal ridge (T) on the side concerned. Each of them is directed dorso-ventrally till it becomes inserted on the coxal apodeme of its side. The fibres of the muscle then pass beyond the said apodeme and making an angle with the latter become deflected posteriorly and get inserted on the outer posterior aspect of the coxal rim.

(viii). COXO-SCUTAL MUSCLE (CxscM) Fig. 12. This is a pair of muscles disposed dorso-ventrally one on each side of the body. Each of these muscles originates from the extreme lateral aspect of the metascutal ridge (T) and gets inserted on the postero-medial border of the coxal rim of the side concerned.

(ix). TERGO-STERNAL FURCAL MUSCLES (TSFuM) Fig. 12. This is a pair of muscles each of which originates from the extreme lateral aspect of the metascutal ridge (T) of the side concerned and travels dorso-ventrally and medially till it gets inserted on the lateral aspect concerned of the metafurca (Fu 3, Fig. 13).

(b). Muscles of metasternum

(i). VENTRAL LONGITUDINAL MUSCLES (2 VlgM) Fig. 13. These are a pair of stout and thick muscles. Each of them originates from the posterior medial border of the mesothoracic furca (Fu 2) close to each other. These muscles are slightly narrower at their points of origin and become gradually widened as they proceed posteriorly towards their points of insertion, on the anterior margins of metafurca (Fu 3). They become slightly divergent near their points of insertion.

(ii). FIRST FURCO-STERNAL MUSCLES (1 FuSM) Fig. 13. These are a pair of small medium-sized muscles. Each of them takes its origin from a point on the imaginary mid-transverse line of metasternum a little away from the outer aspect of the ventral longitudinal muscles (2 VlgM) of the side concerned. These muscles travel postero-medially and a short distance away from their point of origin they travel beneath the ventral longitudinal muscles and get inserted on the anterior margin of the metafurca (Fu 3) undeaneath the points of insertion of the latter muscles. They are slightly expanded towards their points of insertion.

(iii). SECOND FURCO-STERNAL MUSCLES (2 FuSM) Fig. 13. These are a pair of elongated muscles, each of which originates from a sclerite situated sufficiently outward to and at a higher level than the origin of the first furcosternal muscle (1 FuSM) of its side. These muscles also travel postero-medially and become gradually widened as they converge towards their points of insertion, which are common with but underneath those of the two preceding muscles just described. However, some fibres of these muscles also get inserted on the antero-lateral aspects concerned of the metafurca (Fu 3).

(iv). SECOND PROMOTORS OF COXAE (2 Pr'Cx') Fig. 13. This is a pair of well formed muscles having the same origin as the second furco-sternal muscles (2 FuSM) just described. Each of these muscles is diposed posteriorly and becomes directed a little outward when reaching its points of insertion situated on the trochantin of its side.

(v). THIRD PROMOTORS OF COXAE (3 Pr'Cx') Fig. 13. This is a pair of slender small sized muscles each taking its origin from a depression situated a little away from and postero-medially to the sclerite forming the origin of the preceding two muscles on the side concerned. Each of these muscles is disposed transversely and directed outward to its point of insertion on the coxal apodeme of its side

(vi). SECOND REMOTORS OF COXAE (2 Rem'Cx') Fig. 13. These are a pair of small sized thick transverse muscles, each of which originates from the outer postero-lateral aspect of the metathoracic furca (Fu 3). It is disposed transversely and directed outward to become inserted on the inner aspect of coxal rim.

(vii). POSTERIOR FURCO-COXAL MUSCLES (PFuCxM) Fig. 13. This is a pair of elongated muscles. Each of them originates from the outer antero-lateral aspect of the metathoracic furca (Fu 3), is directed outward and slightly anteriorly and becomes inserted on the same apodeme on which the third pormotor of the coxa (3 Pr'Cx') of its side is inserted. These muscles become slightly narrow towards their points of insertion.

4. INTRINSIC LEG MUSCLES

The intrinsic series of muscles of legs comprise such muscles as originate and become inserted within the different segments of the leg. These muscles are responsible for the movement of individual segments of the legs. Most of the intrinsic muscles of the legs take their origin in the segment immediately preceding the one on which they are inserted, but some of them originate further back one or two segments proximal to the segment on which they are inserted.

The main scheme of musclature in all the three pairs of legs is almost the same. Hence, the description of musculature of the proleg given below should suffice to represent the musculature of the remaining two legs as well. However, there is a slight difference in the tibial musculature of the proleg (Figs. 14 & 15) as compared to that in the meso- (Fig. 16) and metaleg (Fig. 17). This will be brought out at the end of the description of the musculature of the proleg.

Intrinsic muscles of the proleg

Six muscles go to constitute the intrinsic musculature of the foreleg (Fig. 14) in the insect under study. They are the depressor and levator of the trochanter in the coxal region, reductor of femur in the trochanter region and levator and depressor of tibia and depressor of pretarsus in the femur region. Their description is as under.

(i). DEPRESSOR OF TROCHANTER (1 dptr) Fig. 14. This muscle originates from the antero-lateral inner aspect of the coxa (Cx). It is composed of two bands of muscle fibres, one of which is shorter and originates along the inner lateral margin of the coxa and the other which is apposed to it originates from the antero-dorsal aspect of this segment. The basis of these bands are very broad, but the bands narrow and converge down as they proceed towards their point of insertion disposed on an opodeme on the inner postero-dosal angle of the trochanter (tr).

(ii). LEVATOR OF TROCHANTER (1 lvtr) Fig. 14. This is a larger muscle composed of three muscle bands closely applied to each other. The inner-most bundle originates from the same place as the larger bands of the depressor of trochanter, but it arises from underneath the latter. Similarly, the second component comes to lie under-neath the larger band of the depressor muscle of trochanter (1 dptr) on the anterior aspect of the first band. The third band which is the largest and lies outermost takes its origin from the anterior and outer margin of coxa (Cx). All these bands like their counterparts of the depressor are broadly based and converge to their point of insertion which too is situated on an apodeme disposed on the anterior and outer aspect of the trochanter (tr).

(iii). REDUCTOR MUSCLE OF FEMUR (rfe) Fig. 14. The reductor muscle of femur is a small wide muscle consisting of two bands. The upper band which is longer originates from about the middle of the inner margin of the trochanter (tr). It is disposed obliquely and its base is broad but it becomes narrow towards its point of insertion, which is situated on the outer aspect of the basal rim of the femur. The second component band of the reductor of femur (rfe) is smaller and is situated below the first one. It gets originated along the inner distal margin of the trochanter and becomes inserted on the inner aspect of the basal rim of the femur (fe), a little posteriorly to the point of insertion of the first band. This band is almost rectangular in outline.

(iv). DEPRESSOR OF TIBIA (dptb) Fig. 14. This muscle is fairly large and occupies the bulk of the space of femoral cavity. It is characterized by its fish-bone like appearance. Its component bundles of fibres originate as oblique or more or less oblique bands along both dorsal and ventral aspect of the femur. Each of these components becomes directed mediodistally so as to be inserted on a common central stem (Ccs), which runs along the middle longitudinal line of the femur. Posteriorly some elongated bands running antero-posteriorly also join the central stem on its posterior terminal portion and become inserted at the base of tibia (tb) along the basal margin of the latter.

(v). LEVATOR OF TIBIA (lvtb) Fig. 14. This muscle is comb-shaped and is composed of elongated bands originating along the entire dorsal margin of the femur (fe) getting inserted on the main stem which runs longitudinally from one end of the femur to the other a little distance away from the mid-central longitudinal line of the femur towards the dorsal aspect.

(vi). DEPRESSOR OF PRETARSUS (dppta) Fig. 15. This muscle which is disposed inner to the former muscle has two roots, which take their origin at two points at the base of femur. The origin of the dorsal root is located on the dorsal aspect of the femur a little distance away from its base and that of the inner root is located centrally at the base of the femur. The two roots are broad at their bases, but as they travel distally they become narrow and converge at a point in the middle of the femur (fe) to get inserted on a tendon-like apodeme (Ap), which travels straight distally traversing the remaining length of the femur. Bending round at the distal end of the femur, this apodeme traverses the entire length of the tibia (tb) and tarsus (ta) running parallel and closer to the inner margins of these segments and gets inserted on the base of the pretarsus (pta) on its inner aspect. The depressor muscle of pretarsus (dppta) serves to flex the tarsal claw ventrally and proximally. Two small muscle fibres get inserted on the aforementioned apodeme (Ap) near the tibio-tarsal joint. One of these fibres originates from the ventral margin of the tibia and travels a short distance disto-medially to reach its point of insertion on the apodeme (Ap). The other muscle is almost similarly disposed on the opposite side. It originates from the mid-outer aspect of the tibia (tb) and travels a short distance disto-medially before it gets inserted on the apodeme. However, in the meso-

(Fig. 16) and meta-(Fig. 17) legs the latter muscle fibre is missing and only the former is present. These presumably supplement function of depressors of the pretarsus.

III. MUSCLES OF THE ABDOMEN

The abdominal muscles in *D. stebbingi* female conform to a generalized plan. They are, however, simplified on account of the fact that there is no overlapping in them.

The following muscles are met within the abdominal region of the female :-

1. DORSAL ABDOMINAL MUSCLES

(i). MEDIAN LONGITUDINAL DORSAL MUSCLES (mlDM) Fig. 18. These are eight pairs of segmentally arranged intertergal muscles disposed close to and along both sides of the mid-dorsal line of the body in the abdominal segments, 1 to 8, there being one pair in each segment. The components of each pair are located one on either side of the segment concerned and run antero-posteriorly and almost parallel to each other. The components of the 8th pair, however, converge posteriorly and meet on the anterior margin of the anal opening (Ao). Thus, these muscles collectively give the look of letter 'U', with a narrow mouth. Each component of the first pair of these muscles originates from the posterior margin of the metascutal ridge (T Fig. 12) on a point close to the mid-dorsal line of the body and after traversing first abdominal segment and running almost antero-posteriorly through it becomes directed slightly outward till it is inserted on the anterior margin of the ante-costal ridge (Ac 1) of the said segment at a point close to but a little away from the mid-dorsal line of the body as compared to the location of its point of origin. These muscles are narrower at their points of origin and wider at their points of insertion. The next six pairs of these muscles are almost similar in disposition. The components of each one of them originate from a point on the posterior margin of the antecostal ridge (Ac 1, Ac 2, Ac 3, Ac 4, Ac 5, and Ac 6) of the preceding segment after traversing the segment concerned they get inserted on the anterior margin of the antecostal ridge of their segment. Their points of origin and insertion are almost similarly disposed on the ridges concerned a little away from the mid-dorsal line of the body on each side. The last or the 8th pair is, however, the smallest and, as already stated, its components converge postero-medially and get inserted on the anterior margin of the anal opening (Ao) located at the posterior margin of the 8th abdominal segment.

(ii). INNER LATERAL LONGITUDINAL DORSAL MUSCLES (illDM) Fig. 18. This series of muscles is similar in number of component pairs, their origin and insertion and their general collective look, to the series of median longitudinal dorsal muscles (mlDM) already described, except that it is situated outer to the latter and the components of its first pair are reverse in disposition to those of the corresponding pair of the first series of muscles. The component of the last, i. e., the 8th pair of muscle of this series have their insertion close to that of the corresponding pair of the first series on the anterio-lateral aspect of the anal opening (Ao). Thus, these two series run almost parallel to each other throughout their length, but they try to meet each other at the posterior extremity.

(iii). OUTER LATERAL LONGITUDINAL DORSAL MUSCLES (ollDM) Fig. 18. This series of muscles is situated outer to that of the inner lateral longitudinal dorsal muscles (illDM) just described. It is almost similar to the inner series except that its component muscles are more regularly arranged to give them a more realistic look of the letter 'U' when looked at collectively. There are 8 pairs of muscles to constitute this series as well and the points of origin and insertion of its components are disposed similarly, but outer to those of the previous two series. However, the components of the last or the 8th pair of muscles of this series traverse a little through the anterior aspect of the 9th abdominal segment before they are reflected slighly to get inserted on the posterior aspect of the anal opening (Ao). This disposition of the 8th pair of muscles of this series gives the appearance of an inwardly projecting notch to the base of the letter 'U', which this series collectively constitutes.

(iv). PARADORSAL MUSCLES (PDM) Fig. 18. The paradorsal muscles have been defined by Snodgrass (1935), as "a group of longitudinal fibres situated on the lateral part of the dorsum above the line of spiracles". The same author points out that the said muscles are sometimes referred to as the pleural muscles, "but since they evidently belong to dorsum they are more properly termed as paradorsal muscles." In *D. stebbingi* the paradorsal series of muscles are situated above the line of the spiracles outer to the points of insertion of dorsal transverse muscles (DtM) to be described shortly. This series runs almost parallel to the series of outer lateral longitudinal dorsal muscles (ollDM) and collectively gives the appearance of letter 'U'. The one respect in which

it differs from the previous series is that its component muscles are 9 pairs instead of 8 pairs in each of the former series. The 9th pair of muscles belonging to this series lies in the last or the 9th abdominal segment and its components are inserted on the same point on the mid-dorsal line of the body.

(v). DORSAL TRANSVERSE MUSCLES (DtM) Fig. 18. These are seven pairs of muscles disposed transversely, but obliquely on both sides in the abdominal segments 2 to 8, there being one pair of these in each of these segments. The components of each pair are disposed one on either side of the segment concerned. The first five pairs of these muscles (DtM 1 to DtM 5) lying in abdominal segments 2 to 6 are similar in disposition, origin and insertion. Each component of these five pairs originates from the anterior margin of the antecostal ridge of its segment (Ac 2 to Ac 6) adjacent and outer to the point of insertion of the inner lateral longitudinal dorsal muscle (illDM) of the segment. It then travels obliquely outward antero-laterally as a bar of uniform thickness and get inserted on the inter-segmental fold lying between its own segment and the preceding segment at a point adjacent and inner to the point of the paradorsal muscle (PDM) of its segment. Each component of the 6th pair (DtM 6) lies diagonally in the 7th abdominal segment in the space enclosed by the outer lateral longitudinal dorsal muscles (ollDM), and paradorsal muscle (PDM) of the said segment on the side concerned in such a way that its point of origin touches on the outer aspect of the point of insertion of the former muscle and its point of insertion touches the inner aspect of the point of origin of the latter muscle. These components too are of uniform thickness throughout their length. However, this pair is the shortest in length of all the 7 pairs of muscles constituting this series.

Each component of the 7th (DtM 7) and the last pair of these muscles originates from the lateral aspect of the anal opening and after travelling straight obliquely outward in a postero-lateral fashion running over the anterior part of the inter-segmental fold between the 8th and 9th abdominal segments reaches its point of insertion which touches on the inner aspect of the point of origin of the paradorsal muscle (PDM) of its side in the 8th abdominal segment.

Acting alone, the tergal muscles straighten or bend the abdomen upward, while working in combination with the sternal muscles they telescope the abdomen.

2. VENTRAL ABDOMINAL MUSCLES

This is a series of 7 pairs of muscles (Fig. 19), the components of which are arranged symmetrically a little outer to and on each side of the mid ventral line of the body in the abdominal segments 1 to 7 in such a way that there is a pair of these muscles to each of the aforementioned abdominal sterna (Ast). All these muscles are of equal thickness and the components of the pairs on the two sides are disposed more or less parallel to each other. The components of the first pair originate emdially from the posterior margin of the metafurca (Fu 3) close to each other. These components are approximated towards their anterior side and diverge posteriorly towards their points of insertion which are situated on the anterior margin of intersegmental fold present between the first and second abdominal sterna on both sides of and a little away from the mid-ventral line of the body. The components of the second to sixth pairs of these muscles are similar in disposition, origin and insertion in their respective segments. Each component of these muscles originates from a point on the posterior aspect of the intersegmental fold between its segment and the preceding segment and after travelling through its segment antero posteriorly it gets inserted on a point on the anterior margin of the intersegmental fold between its own segment and the succeeding segment. The points of origin and insertion of each component lie outer to mid-ventral line of the body on the respective sides.

The components of the 7th pair are similar in disposition and origin to those of the preceding five pairs of muscles, but are inserted on the anterior wall of the second valvifer (Vu 2) a little away from and outer to the mid-ventral line of the body on the sides concerned.

(i). INNER LATERAL LONGITUDINAL VENTRAL MUSCLES (illVM) Fig. 19. This series is almost similar in the number of component pairs of muscles and their disposition, origin ann insertion to the preceding series except that it is disposed outer to the latter and its components on the two sides instead of running parallel to each other are arched outward in the middle. Hence, this series collectively gives the look of latter 'O'.

(ii). OUTER LATERAL LONGITUDINAL VENTRAL MUSCLES (ollVM) Fig. 19. This series also consists of seven pairs of muscles located a pair each in the abdominal segments 2 to 8. The thickness of the components on each side of the body goes on diminishing posteriorly till

the point of insertion of the last component on the lateral aspect of the transverse ridge (TR) between 8th and 9th abdominal segments becomes absolutely narrow and sharp. This series runs outer and parallel to the preceding series in the abdominal segments 2 to 7, but its component in the 8th abdominal segment naturally has no counter-part in the preceding series. The components 2 to 6 of the preceding series and the components 1 to 6 of the series are also similar in origin and insertion. The component 7 of this series, however, is similar in origin to the preceding components but differs in insertion which has already been described. The general disposition of this series gives the look of the letter 'U' with a rather wide mouth and with the transverse ridge forming the base of 'U'.

Acting alone, the sternal muscles curve the abdomen downward, while working in combination with the tergal longitudinal muscles they telescope the abdomen.

3. TERGO-STERNAL ABDOMINAL MUSCLES

These are 15 pairs of muscles (TSM, Figs. 20 & 21) the components of which are equally distributed and symmetrically disposed on both sides of the body in the abdominal region. They can be discussed in two series, classified according to their origin on the tergum. These series are the inner series (first series) and the outer series (second series).

The inner series (first series, Fig. 20 consists of 8 pairs of muscles and the outer series) (second series, Fig. 21) consists of 7 pairs of muscles. The points of origin of the components of the 8 pairs of the first series (Fig. 20) lie at the junction of the preceding and succeeding abdominal segments starting from the junction of the first and second abdominal segments and going up to the junction of the 8th and 9th abdominal segments. These points of origin lie outer to the points of insertion of the respective segmental muscles of the inner lateral longitudinal dorsal series. It may be mentioned that the 8th pair of this inner series (first series) or tergosternal abdominal muscles comes to lie on the lateral aspect of the anal opening (Ao) on the side concerned. These muscles travel dorso-ventrally and are directed outward to be inserted on the corresponding ventral inter-segmental fold on points outer to and touching the parts concerned of the muscles constituting the outer lateral longitudinal ventral series. However, the point of insertion of each component of the 8th pair of this series corresponds to that of the components of the preceding pair and lies touching it on its posterior aspect.

The outer series (second series, Fig. 21) of the tergo-sternals consists of 7 pairs of muscles. They are similar in their points of origin to the first 7 pairs of the muscles of the preceding inner series (first series Fig. 20) of the tergo-sternal except that these points of insertion lie outer to and just touching the part concerned of the outer lateral longitudinal dorsal muscles (ollDM Fig. 20). These muscles travel dorso-ventrally, but they are disposed inward, i. e. just opposite to the disposition of the muscles of the preceding series. In this way, the muscles of the two series are disposed diagonally to each other and form a cross while they just touch each other at the crossing point in such a way that the component concerned of the inner series (first series Fig. 20) lie anterior to it counterpart of the series. In this way the points of insertion come to lie on the corresponding intersegmental fold on the sternum just outer to and touching the parts concerned of the component of the inner lateral longitudinal ventral series of muscles.

All the tergo sternal muscles are compressors of the abdomen, and, therefore, act as expiratory muscles in respiration (Snodgrass, 1935).

4. MUSCLES OF GENITALIA

These are only two pairs of muscles associated with the genitalia of adult female. They are a pair of each of lavators of the first valvifer and retractors of the second valvifer.

(i). LEVATORS OF THE FIRST VALVIFER (lvVu 1) Fig. 22. Each component of this pair of muscles is constituted of long slender fibres and is slightly expanded at its point of origin on the intersegmental fold between the 8th and 9th abdominent segments, a little away from the mid dorsal line of the body and gets narrowed down at its point of insertion, which is situated on the lateral aspect of the first valvifer on the 7th sternum. These muscles travel dorso-ventrally and are directed anteriorly.

(ii). RETRACTORS OF SECOND VALVIFER (rtVu 2) Fig. 22. This pair of muscles lies inner to the levators of the first valvifer and its components are shorter in length as compared to those of the latter. Each component of this pair originates from the posterior margin of the anal opening and runs dorso-ventrally and anteriorly being directed slightly outward till it gets slightly expanded and becomes inserted on the cone-like projection of the second valvifer.

SUMMARY

Muscles of the head, thorax and abdomen and their appendages have been described in *Drosicha stebbingi* female.

(a). *Head*

(1). Muscles of the mouth parts, particularly the Dilators of sucking pump and salivary syringe have been described and their mechanism has been discussed. Besides, muscles of the mandibular bristles, and labium have been described, discussed and their insertion together with their role in the working of mouth parts has been given. Dilator muscle of sucking pump has been shown to correspond to "divaricator muscle" of *Nepa*, 'first dilator' of *Oncopeltus* and "dilator of sucking pump" of *Pyrilla* described by Hamilton, Snodgrass and Butt respectively. No other accessory dilator muscle could be seen in *D. stebbingi* similar to that described in the case of *Leptocorisa varicornis* by Akbar.

(2). Muscles of the tentorium comprising Elevators and Depressors have been sketched and described in detail and their working explained.

(3). Elevators, Depressors and Retractors of the antennae are sketched and their shape origin and insertion have been described.

(b). *Thorax*

(4.) Depressors of pronotum have been observed to be four pairs in this insect, whereas there are generally only two pairs in other Hemiptera.

(5). Occipital dorso-ventral muscles have been found and described for the first time in this Hemipterous insect.

(6). Retractors of profurca, which are also called "tergo-sternal furcal" by Malouf (1932) in *Nezara* have been described. These muscles elevate the head indirectly in *Drosicha stebbingi* whereas in *Nezara* they have been stated by Malouf (*loc. cit.*) to protract the fore legs.

(7). In the thoracic region muscles of flight have been found to be absent since the female is apterous.

(8). Second promotors of coxae in mesothorax have been found and their presence in the insect under study is probably a unique occurrence in Hemiptera.

(9). Oblique intersegmental muscles are present in metathorax only and are absent from the first two thoracic segments.

(10). A peculiarity has been noticed in the second extra-coxal depressor that it bifurcates typically near its point of insertion.

(11). The general scheme of intrinsic musculature in all the three legs has been found to be similar, except that two very small muscles are present in the tibia of proleg, whereas only one such muscle is seen in both meso- and meta-legs.

(c). *Abdomen*

(12). Seventy eight pairs of abdominal muscles have been described, out of which Dorsal, Ventral and Tergosternal muscles account for 40, 21 and 15 each respectively. The remaining two are the muscles of genitalia.

(13). Internal and external muscles have been found to be absent in the abdomen, whereas only lateral and median muscles have been noticed in this region.

(14). Paradorsal abdominal muscles have been noticed in this insect, which again is a matter of unique occurrence in Hemiptera.

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ABBREVIATIONS

a ——The components of *OiM* (Oblique intersegmental muscles).
a 1 ——The anterior component of 1 Pr′ Cx″.
a 2 ——The component of 1 Rem′ Cx′.
Ac ——Ante costal ridge.
adlb ——Intrinsic adductor muscle of labium.
Ant ——Antenna.
Ao ——Anal opening.
Ap ——Apodeme.
ASt ——Abdominal sterna
At ——Anterior tentorial arm.
ATg ——Abdominal terga
b ——Components of *OiM*. (Oblique intersegmental muscles).
b 1 ——The posterior component of 1 Pr′ Cx′.
b 2 ——The component of 1 Rem′ Cx′.
Ccs ——Common central stem.
cla ——Bristle clamp.
clp ——Clypeus.
Cx ——Coxa.
CxscM ——Coxo-scutal muscle.
dlcb ——Depressor muscle of sucking pump.
DlmoM —Dorso lateral median oblique muscle of mesonotum.
DlmoM 2—Droso lateral median oblique muscle of metanotum.
DloM ——Dorso lateral oblique muscle.
dlsyr ——Dilator muscle of salivary syringe.
DmM ——Dorsal median muscle of mesonotum.
DmM 2——Dorsal median muscle of metanotum.
dpAnt ——Depressors of the Antenna.

dpeH ——Depresso extensors of head.
dpH ——Depressors of Head.
dppn ——Depressor of pronotum.
dppta ——Depressor of pretarsus.
dptb ——Depressor of tibia.
dpTnt ——Depressors of tentorium
dptr ——Depressor of trochanter.
DT ——Dorsal tentorium arm.
DtM ——Dorsal transverse muscles.
eablb ——Extrinsic abductor muscle of labium.
eadlb ——Extrinsic adductor muscle of labium.
ECxDp——Extra coxal depressor.
elAnt —— Extensor of Antennae.
elTnt ——Elevators of the tentorium.
exAnt ——Extensors of Antennae.
fe ——Femur.
Fu 1 ——Profurca.
Fu 2 ——Mesofurca.
Fu 3 ——Metafurca.
FuplM ——Furcal pleural arm muscle.
FuSM ——Furco sternal muscle.
Hphy ——Hypopharynx.
HphyW —Hypopharyngeal wing.
iccp ——Inner cephalic capsule.
ilvH ——Intrinsic levators of Head.
illDM ——Inner lateral longitudinal dorsal muscles.
illVM ——Inner lateral longitudinal ventral muscles.
Lb ——Labium.
LbdvM——Labial dorso ventral muscle.
Lbg ——Labial groove
Lm ——Labrum.
LvH ——Levator of Head.
lvtb ——Labial dorso ventral muscle.
lvtr ——Levator of trochanter.
lvVu 1 ——Levator of first valvifer.
Mdlvr ——Mandibular lever.
Mdp ——Mandibular plate.
mjlM ——Major lateral muscle.

mjlM 2 —Major lateral muscle of metathorax.
mlDM ——Median longitudinal dorsal muscles.
mlVM ——Median longitudinal ventral muscles.
mlM ——Median longitudinal muscle.
Mxp ——Maxillary plate.
ObM ——Oblique muscles.
ObdvM——Occipital dorso-ventral muscle.
OiM ——Oblique intersegmental muscle.
ollDM ——Outer lateral longitudinal dorsal muscles.
ollVM ——Outer lateral longitudinal ventral muscles.
oR ——Black oblique ridge.
PDM ——Paradorsal muscles.
PFuCxM —Posterior furco-coxal muscles.
pmdb ——Protractors of the mandible.
pmp ——Sucking pump.
pmxb ——Protractor of the maxillae.
pn ——Piston.
POcr ——Post-occipital region.
Prcx ——Promotors of coxae.
Prcx′ ——Promotors of coxae of mesothorax.
Pr′cx′ ——Promotors of metathoracic coxae.
PreH ——Promoto extensors of Head.
PT ——Posterior tentorial arm.
pta ——Pretarsus.
R ——Prescutal ridge.
R′ ——Angular ridge.
RemCx——Remotors of coxae of prothorax.
Rem′Cx——Remotors of coxae of mesothorax.
Rem′Cx′ —Remotors of coxae of metathorax.
rfe ——Reductor muscle of femur.
rtAnt ——Retractors of the Antennae.
rtFu 1 ——Retractors of profurca.
rtlb ——Reractors of the terminal segment.
rtmdb ——Retractors of the mandible.
rtmxb ——Retractors of the maxillae.
rtVu 2 ——Retractors of second valvifer.
S ——Mesoscutal ridge.
Scp ——Scape.
SdpCx ——Sternal depressors of coxae.

Seg ——Segment.
syr ——Salivary syringe.
T ——Metascutal ridge.
ta ——Tarsus.
tb ——Tibia.
Tdptr ——Tergal depressors of trochanters.
tmlb ——Transvese muscles of second labial segment.
Tn ——Trochantin.
tr ——Trochanter.
TSFuM —Tergo sternal furcal muscles.
TR ——Transverse ridge.
TSM ——Tergo-sternal abdominal muscles.
VlgM .——Ventral longitudinal muscles of mesothorax.
VlgM 1——Ventral longitudinal muscles of metathorax.
Vu 2 ——Second valvifer.

IX. *LIST OF FIGURES.*

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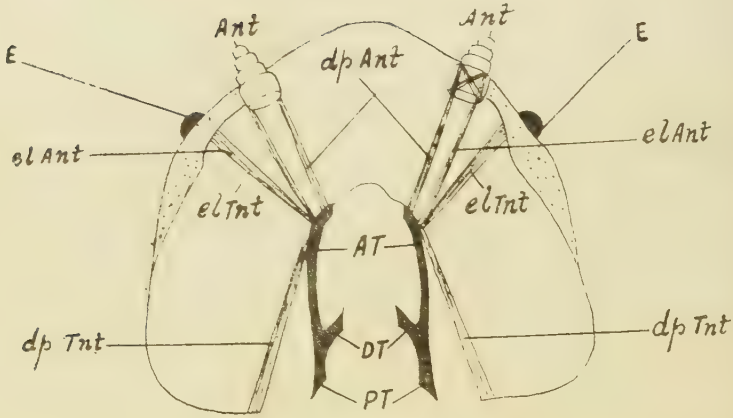
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Ant
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AT
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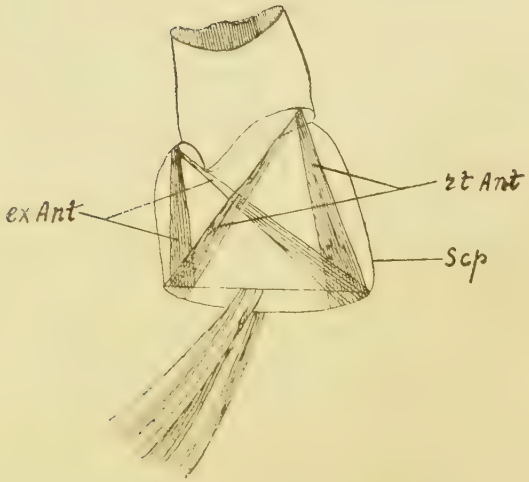
DT
PT

Fig. 1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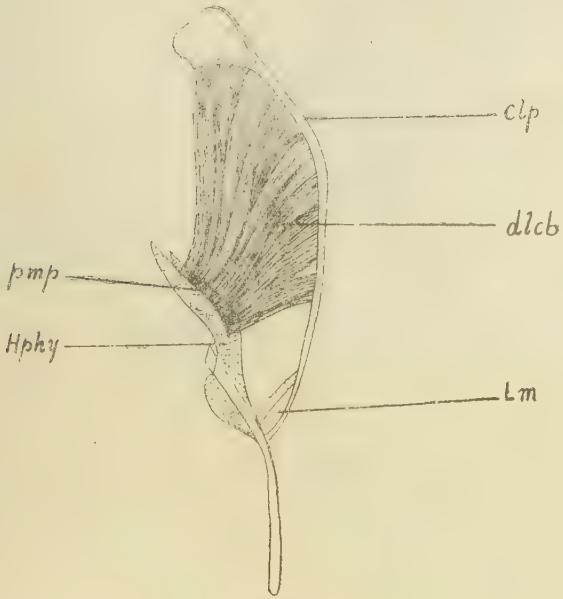
Scp

Fig. 2



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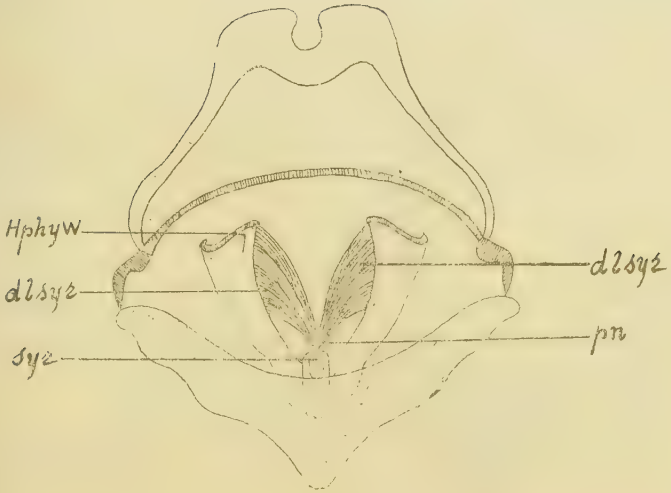


Fig 4

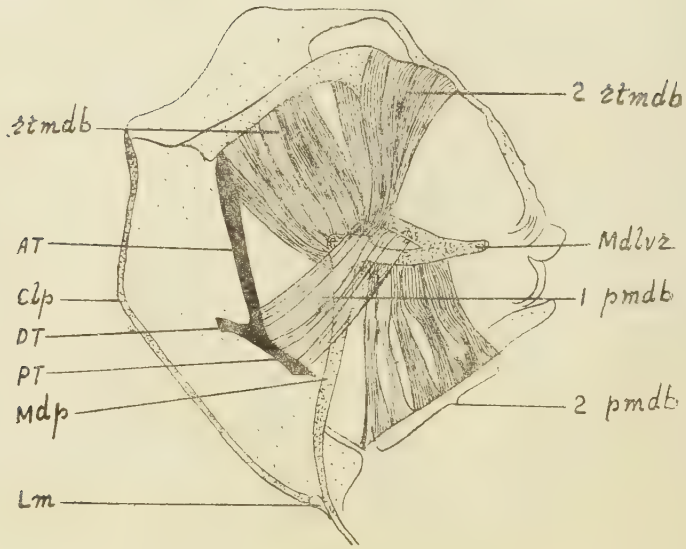

2 ztmdb
ztmdb
AT
Mdlvz
Clp
1 pmdb
DT
PT
Mdp
2 pmdb
Lm

Fig. 5

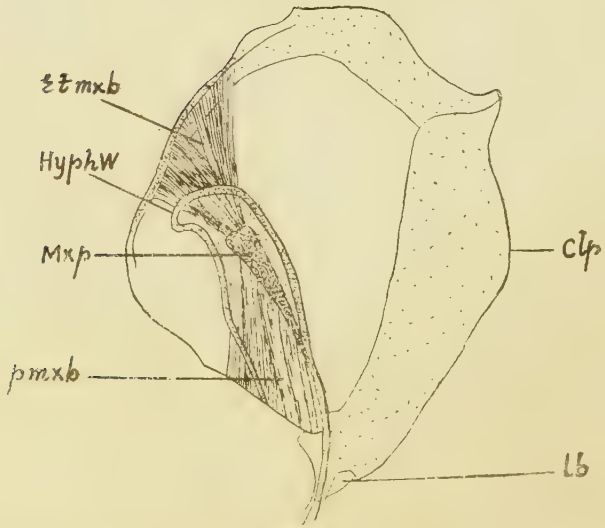

ztmxb
HyphW
Mxp
Clp
pmxb
lb

Fig. 6

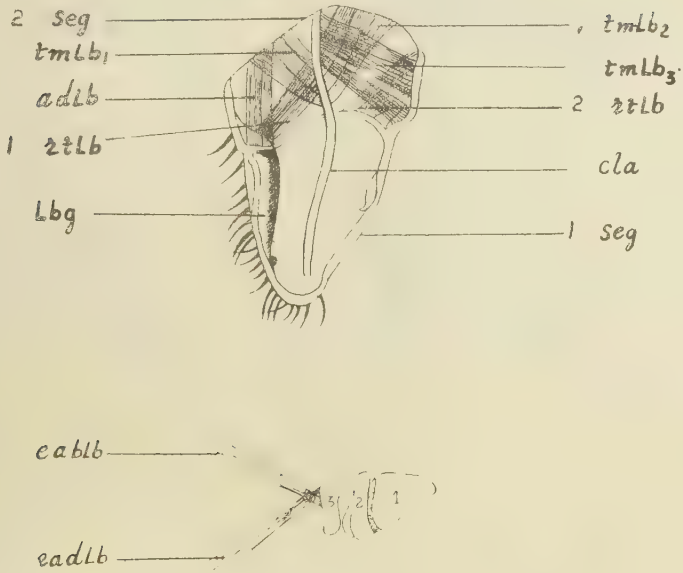

2 seg
tmlb1
adlb
1 ztlb
lbg
tmlb2
tmlb3
2 ztlb
cla
1 seg
eablb
eadlb

Fig. 7

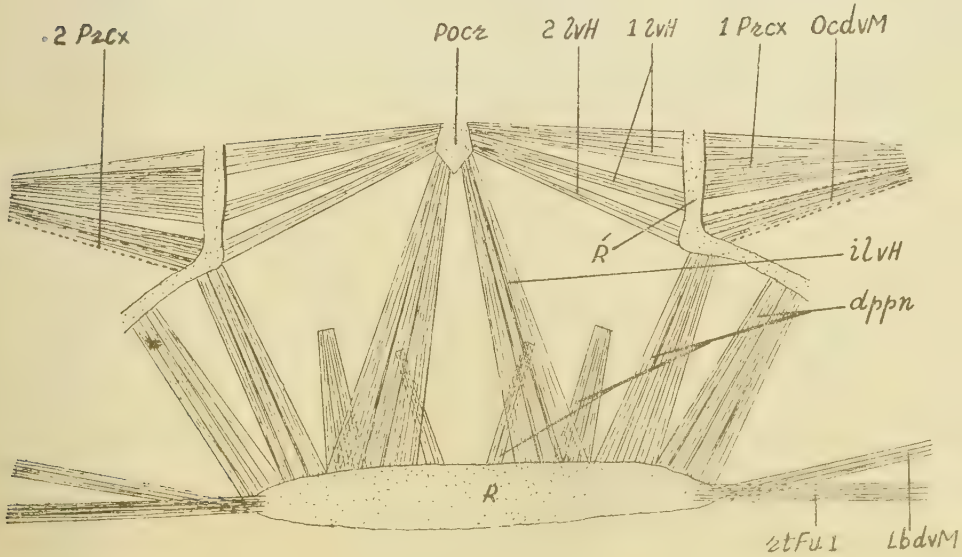

2 Prcx
Pocr
2 lvH
1 lvH
1 Prcx
OcdvM
R'
ilvH
dppn
R
ztFu1
LbdvM

Fig. 8

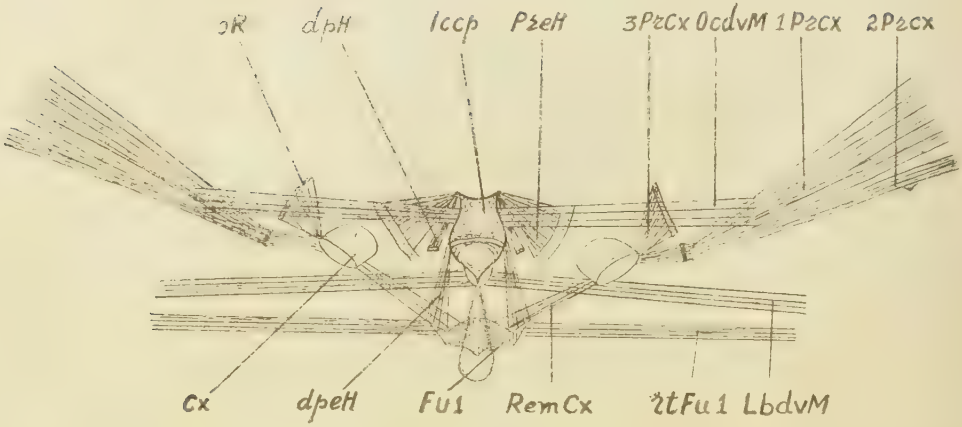

dpH
Iccp
PreH
3PrCx
OcdvM
1PrCx
2PrCx
Cx
dpeH
Fu1
RemCx
rtFu1
LbdvM

Fig. 9

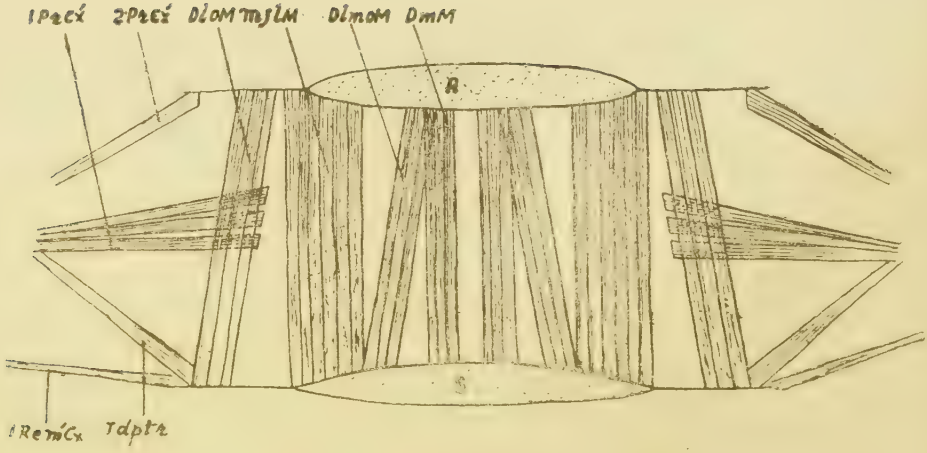

1PrCx
2PrCx
DlOM
mJlM
DlmOM
DmM
R
S
1RemCx
Tdptr

Fig. 10

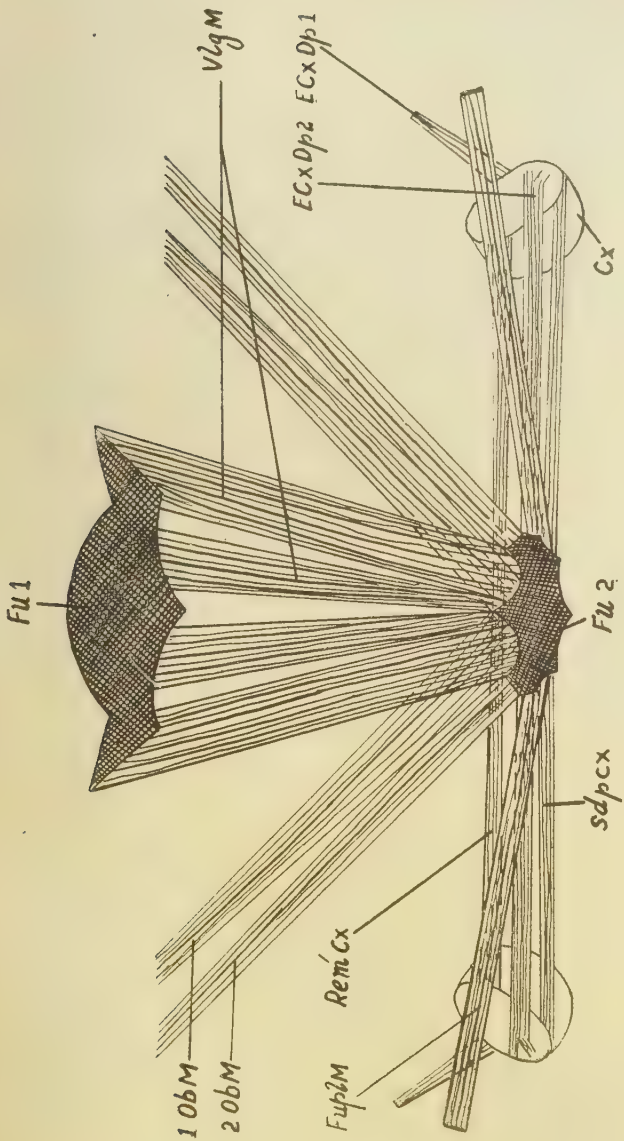


Fig. 11

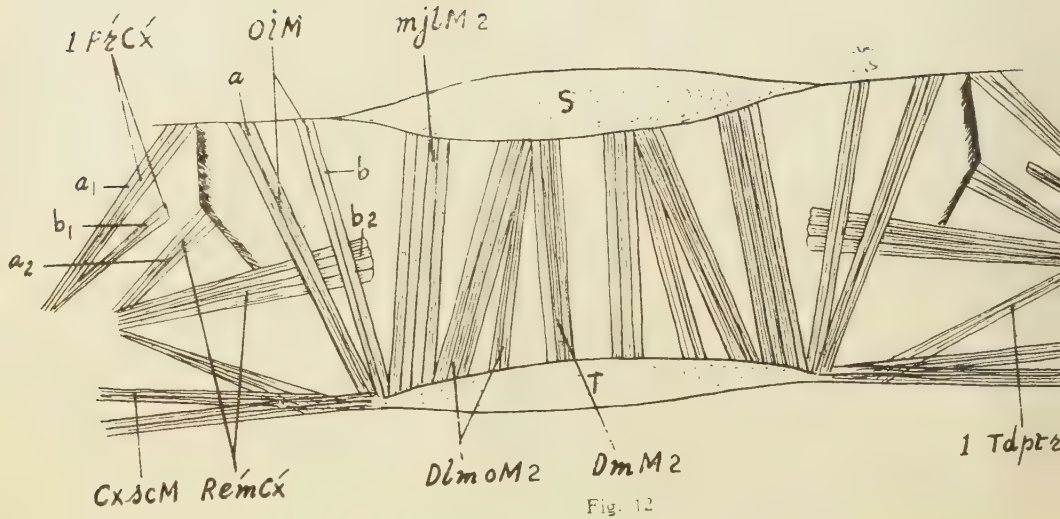

1 PŕCx́
OlM
mjlM 2
a
S
b
a_1
b_1
b_2
a_2
T
CxscM
RemCx́
DlmoM 2
DmM 2
1 Tdptr

Fig. 12

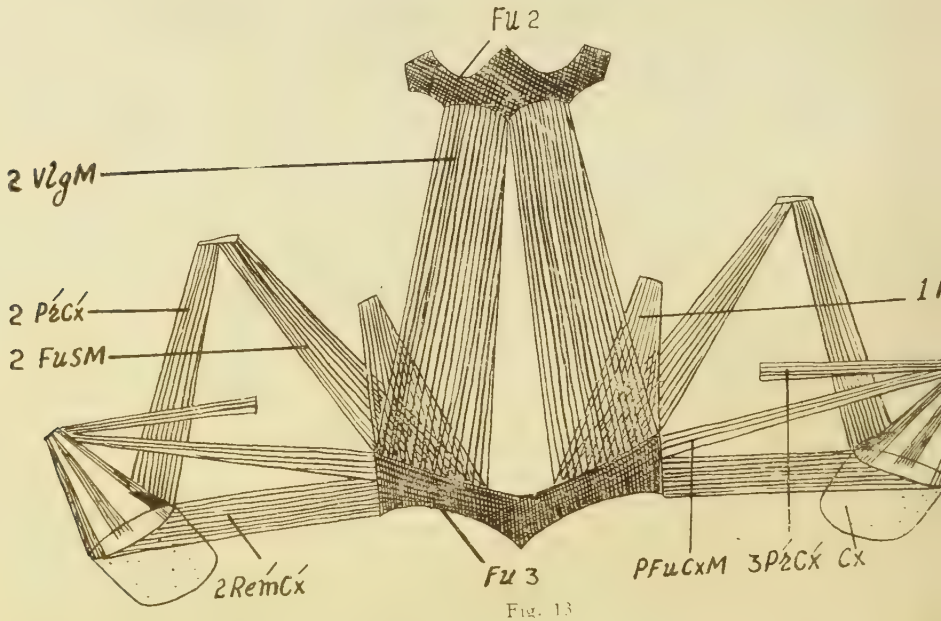

Fu 2
2 VlgM
2 PŕCx́
2 FuSM
2 RemCx́
Fu 3
PFuCxM
3PŕCx́
Cx

Fig. 13

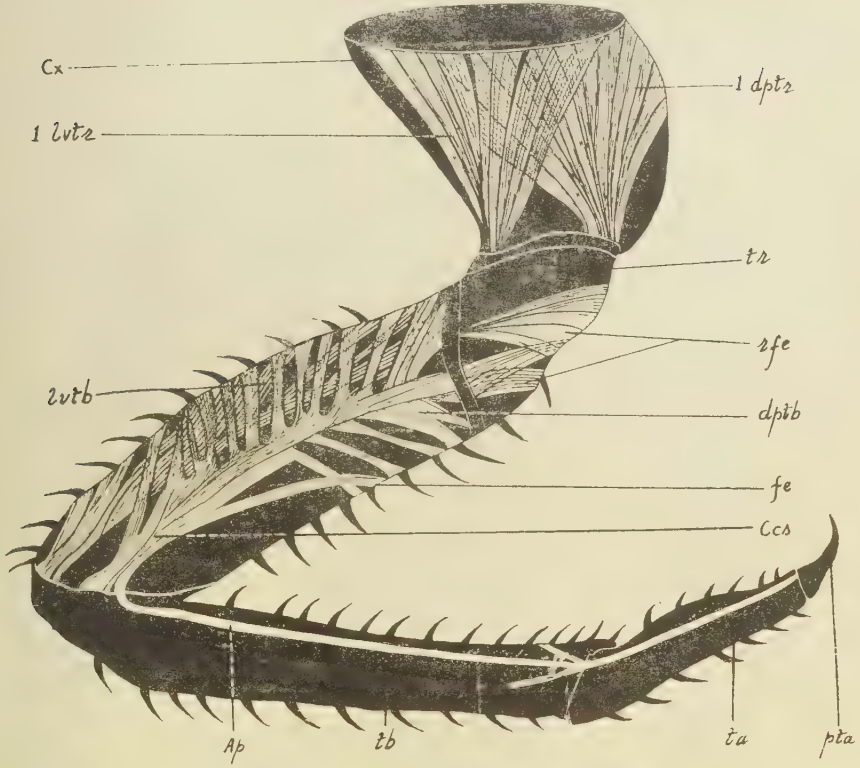
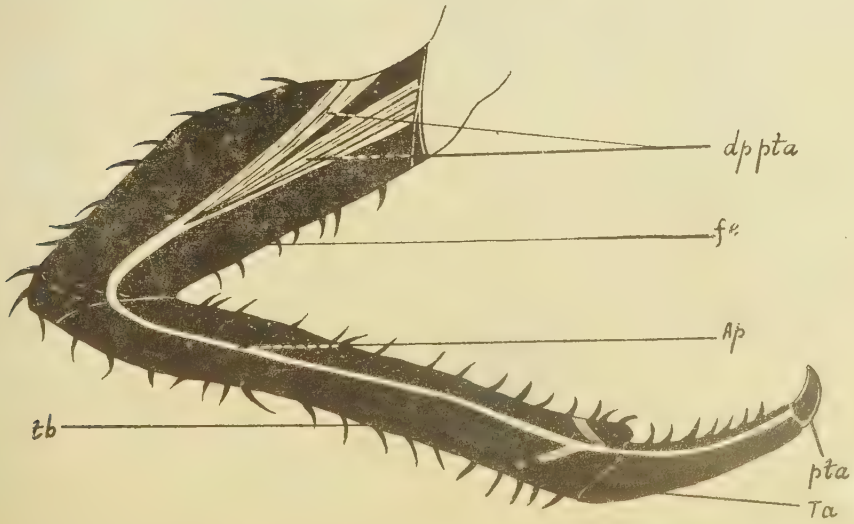

Cx
1 dptr
1 lvtr
tr
rfe
lvtb
dptb
fe
Ccs
Ap
tb
ta
pta

Fig. 14


dp pta
fe
Ap
tb
pta
Ta

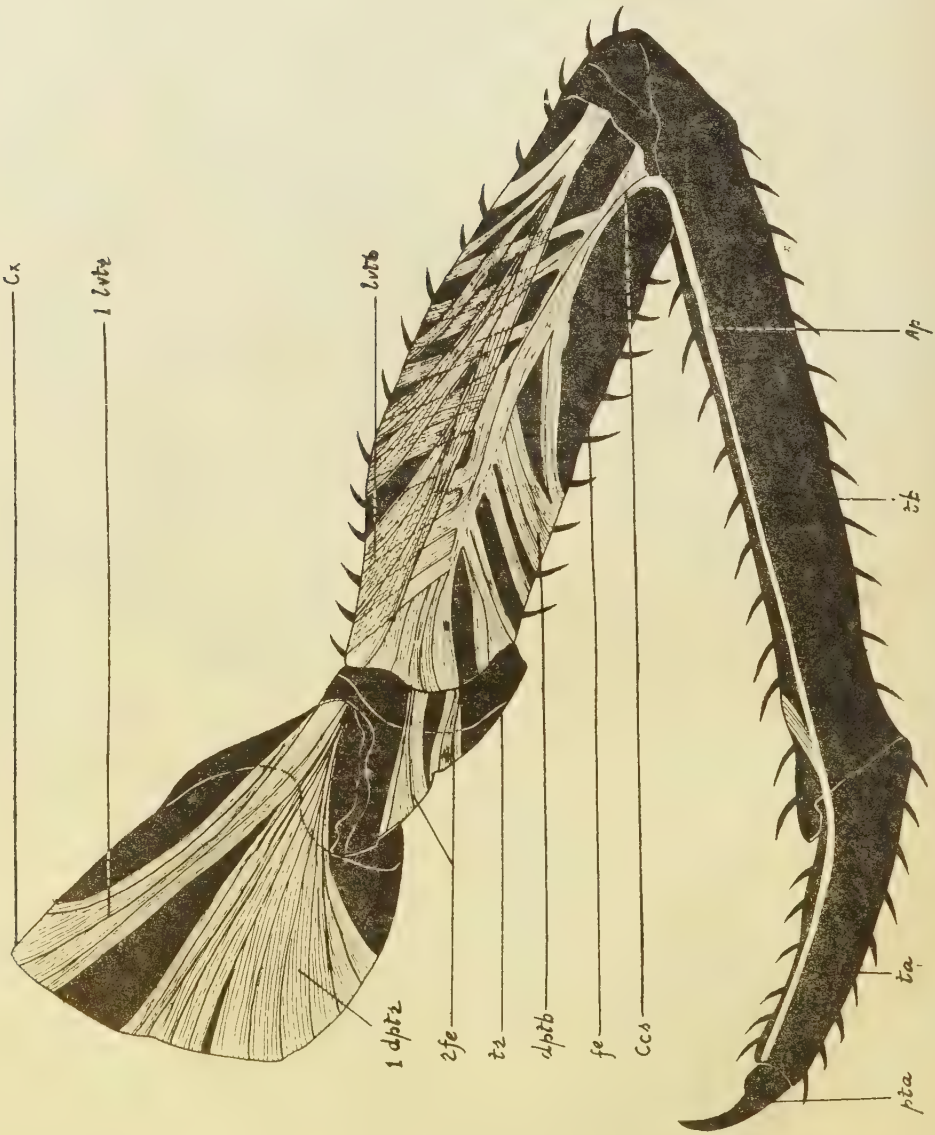


Fig. 16

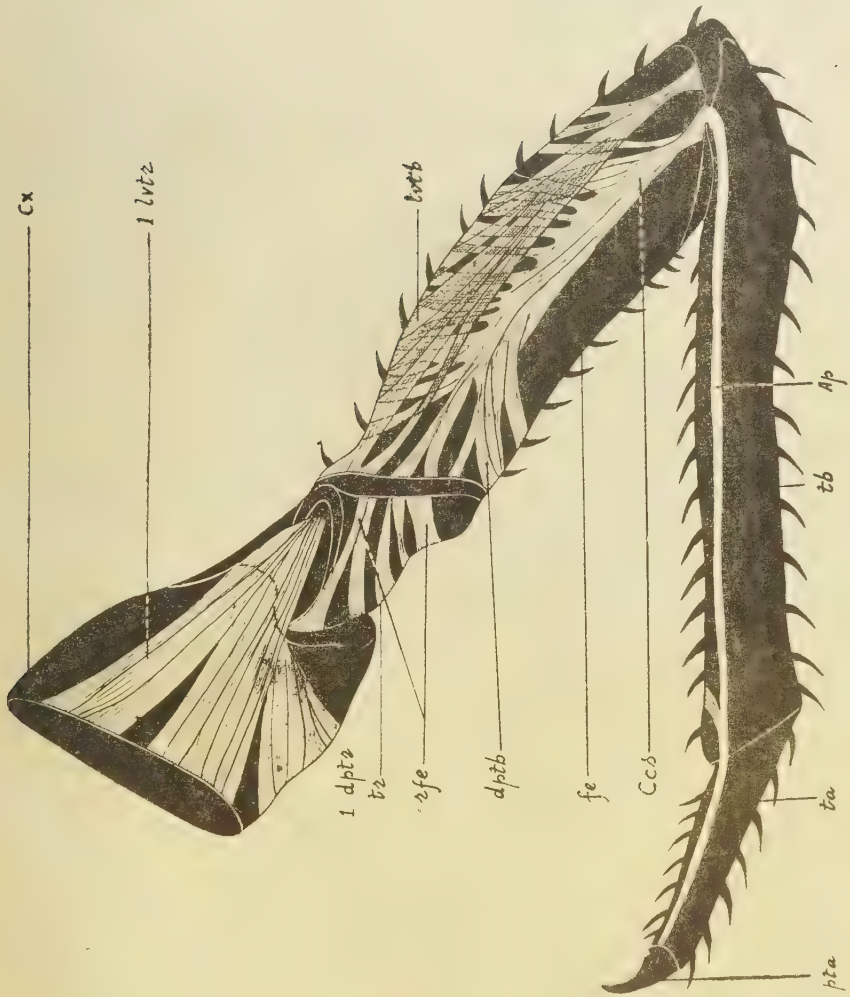


Fig. 17

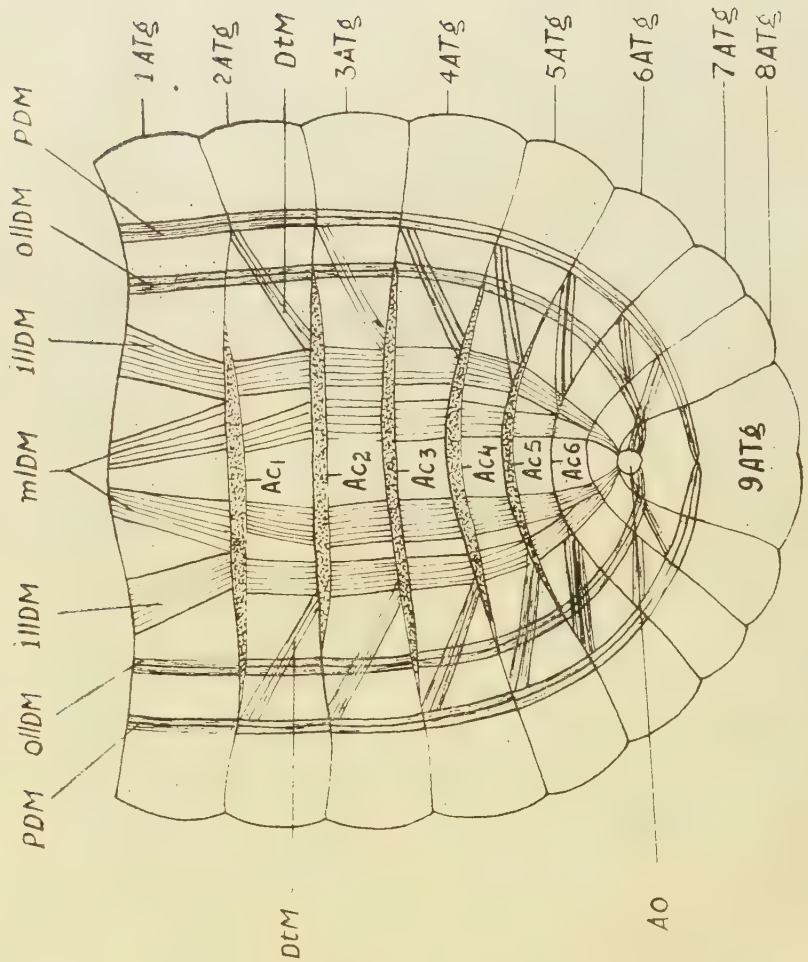

PDM
oIIDM
iIIIDM
mIDM
iIIIDM
oIIDM
PDM
1ATg
2ATg
DtM
3ATg
4ATg
5ATg
6ATg
7ATg
8ATg
9ATg
Ac1
Ac2
Ac3
Ac4
Ac5
Ac6
DtM
AO

Fig 18

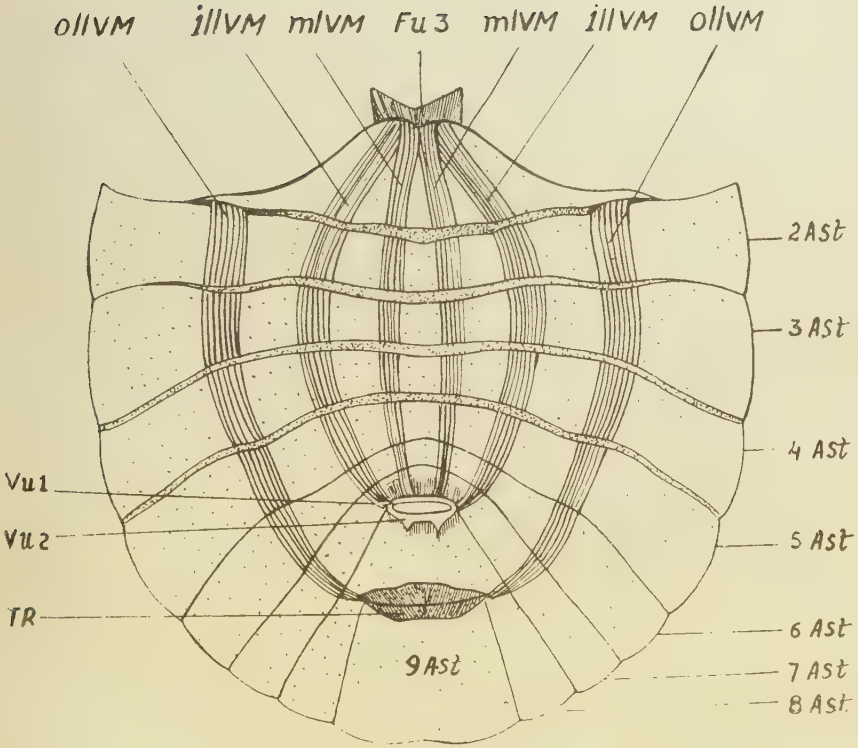

ollVM
illVM
mlVM
Fu3
mlVM
illVM
ollVM
2Ast
3Ast
4Ast
5Ast
6Ast
7Ast
8Ast
9Ast
Vu1
Vu2
TR

Fig. 19

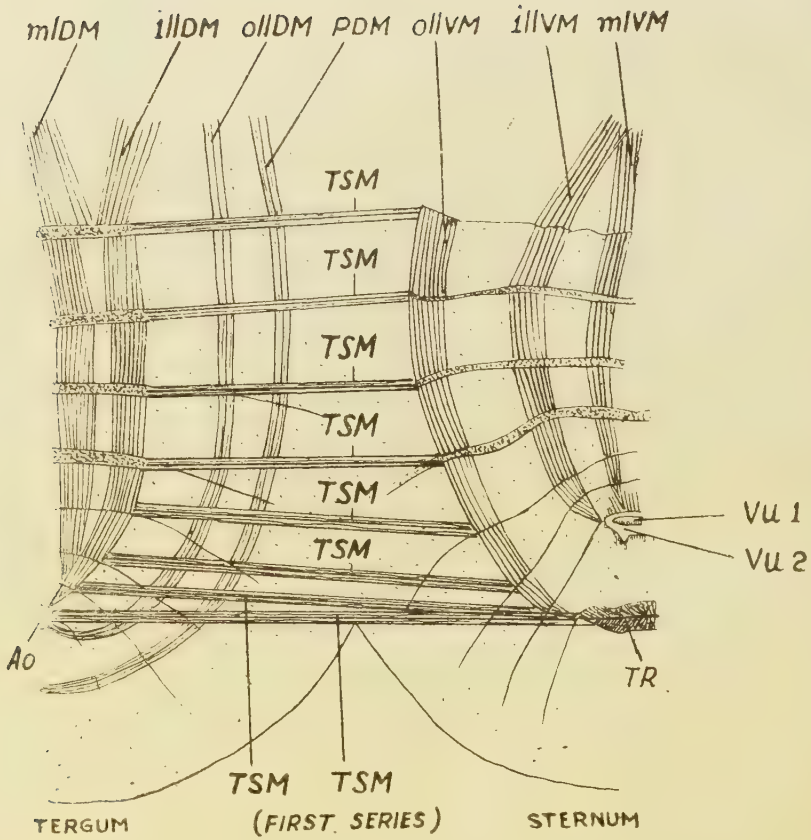

mlDM
illDM
ollDM
PDM
ollVM
illVM
mlVM
TSM
TSM
TSM
TSM
TSM
TSM
Vu 1
Vu 2
Ao
TR
TSM
TSM
TERGUM
(FIRST SERIES)
STERNUM

Fig. 20

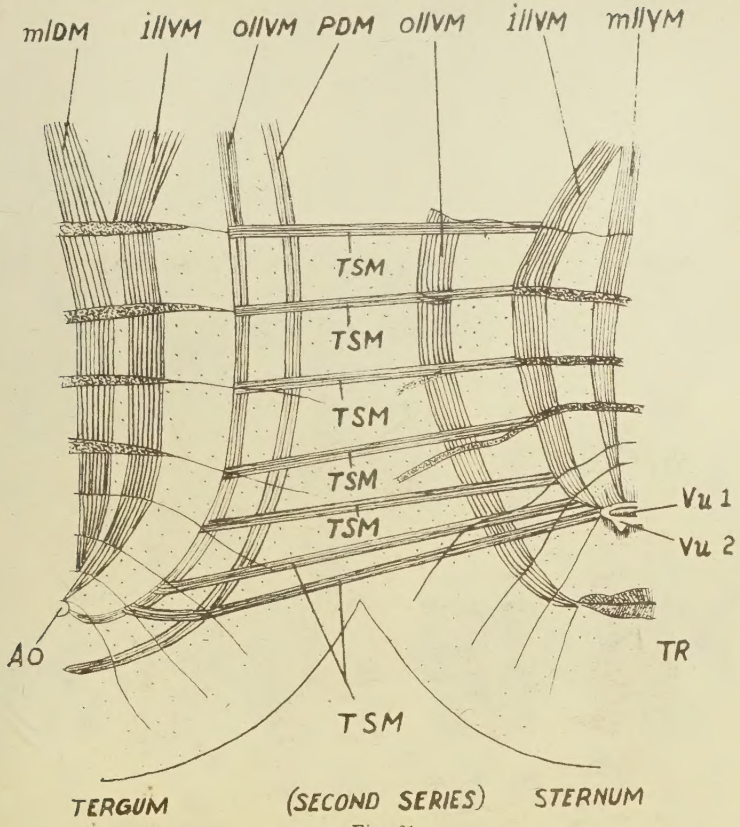

mlDM
illVM
ollVM
PDM
ollVM
illVM
mllVM
TSM
TSM
TSM
TSM
TSM
Vu 1
Vu 2
AO
TR
TSM
TERGUM
(SECOND SERIES)
STERNUM

Fig. 21

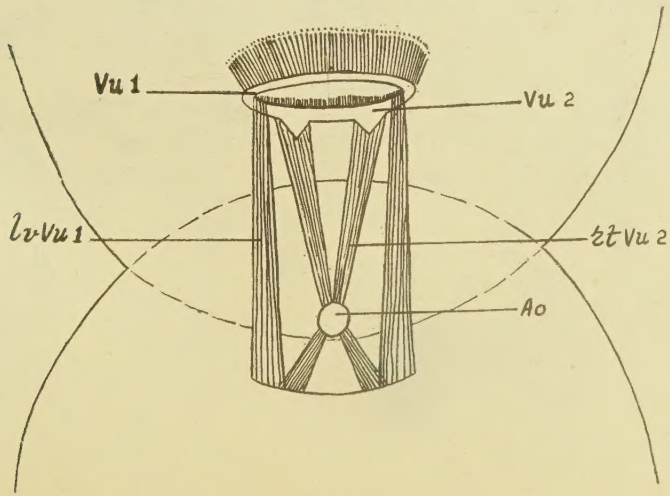

Vu 1
Vu 2
lv Vu 1
et Vu 2
Ao

Fig. 22

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BIOLOGICAL SOCIETY OF PAKISTAN

LIST OF PUBLICATIONS

Biologia, the official organ of the Society, is a journal of biological sciences published twice a year during the months of June and December. It was established in 1955, and is edited by a board headed by Sultan Ahmad. It is available in exchange for publications of a similar character. Previous issues of the journal are also available.

Monograph I. Fungi of West Pakistan by Sultan Ahmad.

This is a list of 1219 species of Fungi collected by the author from West Pakistan. About 1,000 of these are new records for this area. The Monograph is provided with a complete host-index and a large map of West Pakistan and adjoining areas. 126 pp., cloth bound, size 9½ in. x 7 in. Price Rs. 10/- only.

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The codling moth is a serious pest of apples, pears and quinces all over the world, and is firmly established in the former province of Baluchistan. The authors have subjected this pest to intensive investigation for 7 years (1941-1947) and have amassed a wealth of information regarding its distribution, host plants, nature and extent of damage, life and seasonal history, and the natural enemies. The Monograph contains 90 tables and 36 graphs. Price Rs. 10/- only.

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This is a fully illustrated and datailed account of 370 grasses comprising all the species hitherto known from West Pakistan. Keys to genera and species have also been given.

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Part II. Subfamily Pooideae, pp. 153-388, same size, paper bound. Price Rs. 20/-

Monograph IV. Polyporaceae of West Pakistan by Sultan Ahmad.

An illustrated account of about 125 species of Polyporaceae collected by the author from West Pakistan. This Monograph will be published in the autumn of 1960.

Printed and Published by Dr. Sultan Ahmad at the Urdu Press, 83, McLeod Road, Lahore.